School Science
and
Mathematics

A Journal for Science and Mathematics Teachers in Secondary Schools

Founded by C. E. Linebarger

CHARLES H. SMITH
EDITOR
Hyde Park High School, Chicago

CHARLES M. TURTON
BUSINESS MANAGER
Bowen High School, Chicago

DEPARTMENTAL EDITORS

AGRICULTURE—ARETAS W. NOLAN
University of Illinois, Urbana, Ill.

ASTRONOMY—GEORGE W. MYERS
University of Chicago

BOTANY—WILLIAM L. EIKENBERRY
University High School, Chicago

CHEMISTRY—FRANK B. WADE
Shortridge High School, Indianapolis, Ind.

EARTH SCIENCE—CHARLES E. PEET
Lewis Institute, Chicago

MATHEMATICS—HERBERT E. COBB
Lewis Institute, Chicago

MATHEMATICS PROBLEMS—JASPER O. HASSLER
Englewood High School, Chicago

PHYSICS—WILLIS E. TOWER
Englewood High School, Chicago

SCIENCE QUESTIONS—FRANKLIN T. JONES
University School, Cleveland, Ohio

ZOOLOGY—WORRALO WHITNEY
Hyde Park High School, Chicago

THE ELIMINATION OF WASTE IN THE TEACHING OF HIGH SCHOOL SCIENCE.[1]

BY ROBERT A. MILLIKAN,

University of Chicago.

The subject of this address is not one of my own choosing but it is one which I am particularly glad to have had assigned to me, for it seems to me to raise one of the most vital problems in modern secondary school education—namely, the problem of finding how to so organize the work of the high school as to find time, amid the ever-increasing diversity of subjects included in the curriculum and the ever-growing content of each subject to give to the student who can take a full high school course such thorough and consecutive training in the fundamental sciences as a high school graduate ought to have—such training, too, as the corresponding student in practically every civilized country except our own actually gets. It is a problem which, as I see it, has scarcely yet been touched at all in any constructive way in America, and yet one which insistently demands solution, and one which must find solution very soon.

I am quite aware that it is not the physics teacher's *individual* problem, and hence that it may seem out of place on the program of the Physics Section. Indeed, I am not sure that your committee did not intend that I should devote my time to a discussion of the elimination of waste in the present high school physics course. But I choose to take what seems to me a much bigger problem—one in which there is less likelihood of my setting up and then knocking down a straw man—one which lies closer to the roots of our whole American educational system and which is, therefore, worthier of the best effort of the most able teachers.

The methods of teaching our present third or fourth-year

---

course in physics have been dissected and redissected in this section for the past fifteen years, until if we are not all in agreement about every detail, we at least know what are our differences. Furthermore, when we once get behind our party shibboleths and ask how our theories actually work out in practice, we find that the differences are suprisingly small. How small can best be realized by taking all the physics texts which have been written since, say, 1906, skipping all the prefaces and shunning all the articles which have been penned by their authors and comparing the books themselves; or, better still, by watching the actual conduct of classes using these various texts. These books will, of course, show the author's individual characteristics; they will show differences in style, in lucidity of statement, in freedom from errors, in order of arrangement, in up-to-dateness, etc.; but the most striking thing about them after all will be their fundamental similarity. And the reason is not far to seek. It is simply this. The nature and the present state of development of the subject, together with the time available and the dictates of experince, prescribe somewhat closely the main lines of procedure in teaching a year course in physics in the third or fourth year in the high school. Not that I wish to imply that the last word has been said even in this narrow field, and much less that most teachers of physics cannot learn very much more than they now know, or, at least, than they now practice about the teaching of physics. But however good the opportunity for individual improvement may be, the fact is that the field about which I am speaking has been worked over so many times by so many able men for so many years that adding anything of value now is about as promising a task as increasing perceptibly the area underneath an equilateral hyperbola by moving out far along an axis and annexing the space between it and the asymptote.

I shall not, then, waste your time this afternoon in attempting to show how we can save two minutes on a specific gravity experiment, or two hours over the derivation of a lens formula. I wish rather to raise the question as to why we have a one-year, third- or fourth-year physics course at all, and to ask some other fundamental questions as to the relationships of the sciences to one another and to the whole high school program.

As an introduction to these questions, let me present a situation. For the sake of concreteness, I am going to take one which is very close to me. I have a boy who is just entering the high school, a boy who, I think, is typical of a very large group which

I have primarily in mind in writing this address. I have been looking ahead in the endeavor to plan this boy's high school course wisely. There are just sixteen units which he can take in his four years. Of these, three must be in English, and I know of no one who would diminish that requirement. Five, at least, are to be in a foreign language other than English. This cannot be reduced for one who would take Latin, as I want my boy to do, and it ought not to be reduced for one who does not take Latin. Two, at least, must be in mathematics, again an irreducible minimum. No one would think of putting in less than one unit of history, which is indeed specifically required in most schools. One year of handwork is prescribed and one year of physical education, thus making a total of thirteen. This leaves a possible three units of other work, and the sixteen units is full. At the most, then, this boy can get in but three units of science. And if he wants more than one single unit of history, or more than two of mathematics, or if he wants any civics or more than one unit of drawing or shop, or if he wants cooking or typewriting or any other of the myraid, newer, "necessary" ingredients of an education, he must get them either out of these three units reserved for science, or else out of the five units for a foreign language. As a rule, the average student does want one or another of these things, and the tabloid form in which the science is at present administered makes it the easiest subject to slip off the educational platter, and so the three possible units reserved for science are generally cut down to two or less. From what I can learn from inquiry among my acquaintances familiar with high school conditions, I judge that our estimate is very liberal, if we say that the average graduate of the high school has had as much as two years of science. Mr. C. H. Smith tells me that in the Hyde Park High School, where statistics have been kept the average is between one and three-fourths and two units. In the University High School, I was told last week that it was probably less than one and one-half. And this is not at all because the science courses are uninteresting in these schools. Principal Johnson tells me that last year in the University High School, the student vote on the subjects which had been "very much enjoyed" ran—history, sixty-seven per cent; science, sixty-six per cent; French, sixty-three per cent; handwork, fifty-six per cent; mathematics, forty-nine per cent; German, forty-seven per cent; Latin, forty-five per cent; English, forty-three per cent. In the Hyde Park School

they ran thus—English, sixty-three per cent; French, sixty-one per cent; science, fifty-nine per cent; history, fifty-three per cent; German, fifty-two per cent; mathematics, fifty-two per cent; Latin, forty-one per cent. So that science in both these schools was well up toward the top, and I know of no reason to suppose in spite of all the lugubrious talk which is heard about "interest in science" that this is not a perfectly general situation. In the Englewood High School, eighty per cent of all graduates have elected Mr. Tower's physics. This whole "interest" question in science is one with which I have so little patience that I shall dismiss it with the single remark that any teacher who doesn't make any science interesting hasn't any excuse for being a teacher at all. Science is pretty nearly the only subject in the curriculum which you can scarcely keep from making interesting, no matter how badly you teach it. The fact that science does not enter more largely into the average student's course has not in my judgment anything whatever to do with *interest*. It is due chiefly, I think, to an administrative situation, to the crowded nature of the curriculum, to the mistaken shoving over of the sciences to the later years of the course, and to the fact that we have not tied them together into a whole, but have kept them in pellet form so that they have been especially easy to crowd out. Like so many other unfortunate American situations it is due, I think, chiefly to lack of intelligent organization.

But the fact that a student taking a normal high school course can scarcely get in more than three units of science while the average which he does get in is probably less than two raises two very vital questions. These are:

1. How can the time which now seems actually available for science in the high school be most effectively utilized?

2. Can another scheme of science instruction be developed which will give more adequate scientific training to our high school graduates?

The first question answered itself very quickly for my boy because his mother who is an ardent classicist, but withal a very efficient and practical person, handled the case in the omnibus capacity of judge, jury and executioner. The trial ran somewhat as follows: "How many units of science can he take anyway?" Answer, "At most three!" "Very well, that settles it. I took primarily Latin and Greek but I found time for physics, chemistry and biology because every intelligent person ought to know something of those three subjects. The need is just as strong

now as it used to be, so those are the boy's three science units." "But," said I, "general science is a possibility." "But will he not get all that in his three fundamental sciences, and in just as interesting and in much more thorough and useful form? Then, why waste the time on general science? Besides, even if that be good, it is a choice between the good and the indispensable. Which of the fundamental sciences shall be replaced by the general science?" and the sentence was pronounced.

Now a mere academic person like myself could have argued the matter at indefinite length—and in fact, I did sit for a good part of a year at biweekly intervals with a group of savants and discuss this very question—but I am sure that most, if not all, of you will agree that the above judge stated the simple common sense of the general science situation. In fact, I have never known anyone who had given the subject careful study who felt that the general science course was in any way an ultimate solution of our high school science problem. This conference which I have just mentioned felt that the place of the general science course was in the grades. Dr. Judd has often expressed to me the view that it belongs farther down. My friend, Prof. Caldwell, joint author of one of the general science texts, which as a matter of fact, I myself had some share in getting started, believes that its destination is the first year of the junior high school. But this junior high school science will have to be something quite different from the present general science course. Nevertheless, the general science course even in its present form does seem to me to fulfil a useful function, for with the increasing diversity of our school problem, with our domestic science courses and our agricultural courses and our two-year courses, and our vocational courses generally, there are quantities of students who cannot take more than a single year of science anyway. For such the present general science course seems to me suitable. It does not seem to me to be suitable for the student who can have the advantage of a full high school course unless he has a year of time to waste, and it is this continual wasting of time in our lower education which has already put the American boy two years at least behind his European brother. This waste could perhaps be eliminated partially with a general science course in the first year of the high school if we were to reconstruct entirely the courses in the individual sciences and build them all upon the first-year science course. Such a reconstruction seems to me neither practicable nor desirable, especially since I think the

result aimed at can be accomplished much more easily and much more naturally. Particularly undesirable and ill-advised seems to me legislation requiring all first-year students to take first-year general science.

This brings me to the second and more vital question for it deals with the possibility of a constructive program. And here I am speaking in part, though not entirely, as an outsider and a theorist. Your judgments will here be as good as or better than mine. I wish to urge, however, some general considerations which, coupled with your experience, may possibly lead to some real advance.

Let us begin with a comparison of American and European secondary education in science. A few months ago I was asked to pass on the credentials of a young Dane who sought entrance to the University of Chicago. He came from a gymnasium in Copenhagen and brought with him his schedule which I carefully examined. In science, it had been as follows: In the sixth year from the end, i. e., at the average age of twelve or possibly thirteen, the students in this school had begun simultaneously physics, chemistry and botany. They had physics for five straight years, three hours per week, chemistry for five years, one hour per week; botany for four years, one hour per week. Zo-ology began in the fifth year from the end and continued for five years, two hours per week. My Danish informant told me that this was the *uniform schedule* in all Scandinavian countries. This schedule relates, I suppose, to the real gymnasium. However, a young friend of mine who is a graduate of one of the German classical gymnasia informed me last month that even in these conservative schools, all pupils start at about the age of twelve with physics, chemistry and biology and cover in several years fully as much ground as is covered in our best high schools in courses in all of these three subjects. The textbooks used in these schools I have studied somewhat carefully myself. They correspond quite closely with ours. Most of them develop the subject in essentially the way used in our standard texts. I have examined, too, the French elementary texts in physics and find them more complete and more difficult than ours. I am told by those who should know that the science instruction in France is even more thoroughgoing than in other countries in Europe.

At any rate, there can be no question about the essential correctness of these main facts:

1. In all European countries there is universal recognition of the fundamental importance for all students of thorough consecutive training in all three of the subjects—physics, chemistry and biology—with the strongest emphasis thrown upon the physics.

2. Instruction of about the same difficulty as that given in our secondary school is begun *in all three* of these subjects at about the age of twelve and homogeneous groups pursue these studies in parallel through from three to five consecutive years.

3. There is probably no highly civilized country in the world in which the average student is not given more thorough training in these fundamental sciences than he is given in the United States.

Now I should be the last person in the world to urge that everything is good because it is European. The world's European ideals, both as to men and institutions, are today lying in the dust. Men and nations whom we thought great and glorious have proved themselves to be pitifully ignoble and unworthy in some respects. Nevertheless, the universal experience of the European nations in the matter of teaching of the sciences may yet have a lesson for us, particularly if the procedure suggested by it shows itself upon analysis to be based upon sound principles.

Now the first of these principles which seems to me absolutely sound is that physics is a science which is as well adapted as any science, perhaps better adapted than any science, to arouse the interest and to appeal to the understanding of the child of from twelve to fourteen years of age. Why have we in the Chicago schools pushed it off into the fourth year? I cannot conceive of a worse place for it. Logically, it unquestionably comes first. Well-known educators, Dr. Judd among them, have repeatedly expressed the view that it ought to be first. Those interested in the pedagogy of mathematics have repeatedly urged that physics precede or accompany the mathematics so that the former's wealth of material might be available for illustrative purposes in the latter. But since the biological sciences now actually do precede in the United States, and since further, the advantage claimed for general science of co-ordinating the different sciences can be gained just as well and without any waste at all by teaching the three separate sciences in parallel, what I want to urge is not the European plan of stressing physics but simply the European plan of a continuous three-year science course in which physics, chemistry and biology shall be taught in parallel, say, each two hours per week.

Now, what are the objections to such a plan and what is to be gained by it? Let us take the objections first. It has been urged that the physics should come late in the course because the student needs his mathematics in order to help him in his physics. This contention has always seemed to be untenable. There is no mathematics needed in elementary physics even as it is now taught, except the simplest algebraic equations with one unknown, and the single geometrical proposition of the proportionality of the sides of similar triangles. Last year I had an eleven-year-old boy in the eighth grade of the public schools (the Ray School) and I found that, entirely unbeknown to me, he had been taught in his grade work how to handle similar triangles, and that he was actually solving problems with their aid. I found, too, that he was solving algebraic equations with one unknown. At the present time then, all the rudimentary mathematics needed for high school physics is being taught in the grades. If it were not we could teach it in connection with the physics in an extra half hour of time.

Having always believed that we pushed off the physics to too late a period, I began this fall an experiment on this same boy who was then just entering the high school. He had just passed his twelfth birthday and was, therefore, from one to two years younger than the average first-year high school boy. Under normal conditions I would have preferred to put him with a class in physics of his age and advancement, but no such class being available I put him into a class of seventeen-year-old boys in the third year of the high school. This boy is in every way a thoroughly average, careless boy of twelve, who gets an average grade of B. He has been making thus far just his average grade of B in this physics. I have watched him carefully but have helped him not an hour thus far, all told. He is now beyond the subject of "falling bodies," the hardest subject in physics, and has had no difficulty whatever which is due to his years or lack of preparation, not a quarter as much difficulty as our thirty- or forty-year-old pupils in the summer have in elementary physics because of their years. I am greatly pleased with the way in which the experiment is working in this one case. The boy is at the age at which his interest in and appreciation of the facts of physics are most keen, and the possibility of teaching and driving home a little elementary algebra through it is fascinating.

But why should not this experiment work? This is not the

first time it has been tried. That the age of twelve or thirteen is a suitable one at which to start a boy in physics is not at all a theory. It is not merely my individual experience. It is the universal experience of European schools. For that matter, the first part of the course in general science, so far as I have been able to observe, is merely a part of the physics course taken over into the first year. The fact is there is every reason for beginning physics as early as possible in the high school course and no valid reason for not doing so.

A second objection to the proposed plan is that it might be difficult to administer because of irregular students and transfers between schools. And here we come to the very heart of the question. Here we strike what seems to me the weakest spot in the whole system of secondary education in the United States. In Europe, continuity, thoroughness and a well-trained, efficient product are secured because the whole course is planned for the regular, normal student. Here, too often, every sound pedagogical principle is sacrificed to the convenience of the irregular, abnormal and inefficient student. Why should we put up our science in tabloid doses just to make it as convenient as possible for any student to begin at any time he wants to, to take just as many tablets as his convenience or his whim suggests, and to stop taking at any time without suffering the slightest conceivable inconvenience? Why should we not rather plan a consecutive three-year science course for students who plan to take a full high school course, even if irregular students should suffer some trifling inconvenience because of their irregularity? With the co-operation of schools between which transfers are most likely to be made, it could be done with almost no inconvenience or loss due to transfers anyway. No new texts are needed; for the courses in the individual sciences need not differ essentially from those now given. They would simply be taught in parallel and for the sake of gaining the element of co-ordination which is urged for the general science, it would be desirable that all three sciences, physics, chemistry and biology, be taught *by the same* teacher or teachers, or at least under the immediate supervision of one head science teacher. Of course there would be some omissions from the present texts and ultimately some reconstructions of the present courses but no radical changes are needed.

Now let us enumerate some of the advantages of such a plan:

1. Most students who took science at all would have a continuous, systematic, progressive, three-year course in the fundamental sciences—a result which would be welcomed, I think, by

practically all educators, whether scientists, classicists or philosophers. Students might, of course, drop out after one or two years, but if they did so they would know that they had not finished their first course in any one of the sciences. They would not be encouraged to think that they had completed their scientific education because they had had the equivalent in some one subject of Steele's *Fourteen Weeks*.

2. Pupils would begin both the physical and biological sciences at the very beginning of their high school course at the age at which their minds are most alert and eager for such work.

3. The utterly ridiculous situation of the most fundamental of the sciences being pushed off to the last year of the high school would be at an end, and this change would have been made not at the expense of biology, but greatly to its advantage, for the physical and biological studies would supplement each other through three years of the pupil's growth, and all the advantages now claimed for general science, and more, too, would be gained without the loss of a year of time and without the necessity of a reconstruction of courses in the individual sciences which decades of trial and elimination and addition in both Europe and America have brought to their present form.

4. The advantage to mathematics of being taught to students who were having, or had had, enough of physics to make its concrete imagery available for the mathematics course would be very great.

5. The days of tabloid science would be at an end and one of the chief evils of American education in science, namely, lack of any intelligent organization, would have been corrected. The work of the individual teacher in the better schools in this country seems to me to be in no way inferior to the best work in Europe. The element in which we are hopelessly behind is organization.

I realize, gentlemen, that this is a big problem—that is what makes it so interesting and so worthy of your best efforts. I realize, too, that it is not your problem alone for you are helpless without the co-operation of principals and superintendents, but if you will go to them with a constructive program, I think they will lend a willing ear. I realize, too, that one man and one school cannot swing it alone. But if it is worth doing, then the science teachers of a city like Chicago are big enough to put it through.

Is not an experiment of this kind at least worth trying in the United States?

DISCUSSION BY CHARLES H. SMITH,

Hyde Park High School, Chicago.

Abstract.

I do not propose to discuss at any considerable length this admirable paper by Dr. Millikan, but in place of such a discussion I wish to present a few things which have occurred to me to be of great importance in the teaching of secondary school science.

We hear nowadays very much about insurance of one kind or another. In the case of the destruction of a building by fire, some one says, "Oh, he did not lose anything. He was well insured." What nonsense this is. Somebody had to stand that loss, and indirectly it is you and I. The destruction of our property is a calamity, and is something that everyone feels. In secondary school instruction where the highest efficiency is not maintained in every and all departments, every child, every parent, every taxpayer, and every teacher must be drawn upon to supply the loss. The remedy, of course, is to secure those ends by means of which only the very highest efficiency can be attained.

There is inexcusable waste, wherever instructors use poor or undesirable apparatus, which is forced upon them by Boards of Education buying the cheapest material, whether it meets the needs of the school or not. Science instructors should get together in order to standardize apparatus which they are obliged to use, and in this way eliminate the dealer in second- and third-class material. Any firm selling apparatus which is not up to standard quality is not only undermining its own business, but placing distrust in the minds of instructors with reference to reputable firms. And they are, at the same time, bringing about a condition in the retarding of science instruction in all of its phases which is more serious than many can realize.

Nonpreparedness of an instructor in the subject which he is attempting to teach is another source of inefficiency and waste. This we find both in the old and young instructor. Frequently, the young instructor is full of conceit as to what is the right way of doing his work, and is apparently not willing to learn from older heads. They surely should know the history of the methods of teaching in the science in which they are working. This can be secured in no better way than by advice from those who have gone this way before them. Many old

instructors have gone to seed, and are unwilling, or too indolent to keep up-to-date in their line of work. They thus retard the progress of science, and the school cannot produce the best results while these men are still in the game.

In many schools there is lack of co-ordination of the subject matter. Many instructors from my personal knowledge are apparently simply putting in their time without any attempt to give a co-ordinated course.

In every science laboratory where there are seventy-five or more pupils under one instructor, there should be an assistant whose business is to look after the getting out and putting away of apparatus, keeping it in repair, and doing other such minor details, so that the instructor's time may be better conserved for the purpose of doing more teaching, and the developing of his course to a higher degree of efficiency. Boards of Education are here saving at the spigot and wasting at the bunghole.

Again there is altogether too much apathy on the part of instructors in keeping in touch with others who are doing the same or other kinds of work in other schools. They have no interest in attendance upon meetings of this character. The fellow who ought to be here is not. The only incentive which keeps him in line is the salary which he is drawing. Those fellows, too, are not keeping up to the times with the current literature of their subjects. They are not on the subscription list of any Journal which will keep them fresh in their work. The people of this nature and stamp are wasting the facilities of the school. The only way that these people can be improved is to get new teachers for their places. They are no longer useful in their school work.

Another valuable way in which we could eliminate waste would be for the government to establish, say, three typical government high schools, one in the East, one in the Central West, and one in the West. These schools would embody in every detail all of the good qualities of every up-to-date high school in the country. They would be thoroughly equipped with all forms of apparatus and material for teaching science as well as every other subject, and they would be manned and womaned by persons equipped with ability and experience to handle such a school. To these schools then, instructors could go to find out the kind of apparatus to buy, and how to use it. They could also learn the methods of up-to-date teaching.

Another source of wastefulness is the too rigid course, compelling boys and girls to follow a prescribed program which in

too many instances is altogether unsatisfactory to the pupil who is compelled to undergo this uninteresting intellectual surgical operation. The courses should be made to fit the pupil, and not the pupil to fit the course.

And, lastly, there should be established in every high school, and especially in the science branch of it, at the very beginning of the pupil's high school career, a course which will enable him to correlate his various energies so that he will be able to manage himself in the best possible way, and not waste so much of his time in attempting to study when he does not possess even the rudiments of this science.

DISCUSSION BY WILLIS E. TOWER,

Englewood High School, Chicago.

The discussion of this subject by Mr. Charles H. Smith of the Hyde Park High School ends with the suggestion that one of the best ways of preventing waste is to teach our high school students "HOW to Study." This matter has been considered by many teachers. In Englewood High School we have found a sheet of suggestions upon "How to Study" very helpful. Copies of this will be passed to each one present. Make whatever use of these suggestions that seems helpful to you.

HOW TO STUDY.

The HABITS OF STUDY formed in school are of as great importance as the subjects mastered: YOUR DAILY AIM should be TO LEARN YOUR LESSON IN LESS TIME, or TO LEARN IT BETTER IN THE SAME TIME. The following suggestions, if carefully followed, will help you make your mind an efficient tool.

1. Understand the lesson assignment. Learn to take notes on the suggestions given by the teacher when the lesson is assigned. Take down accurately any references given by the teacher. Should a reference be of special importance, star (*) it so that you may readily find it. Pick out the important topics of the lesson before beginning your study.

2. Provide yourself with the material the lesson requires; have on hand maps, ruler, compass, special paper, or whatever is needed.

3. Do not lose time getting ready for study; sit down and begin to work at once. Concentrate on your work, i. e., put your mind on it and let nothing disturb you. Have the will to learn thoroughly yet without wasting time.

4. LEARN TO USE YOUR TEXTBOOK. The following devices will be found helpful—index, appendix, footnotes, maps, illustrations, vocabulary, etc. Learn to use your textbook, as it will help you to use other books. Therefore understand the purpose of the devices named above and use them freely.

5. In many kinds of work it is best to go over the lesson quickly, then to go over it again carefully; e. g., before beginning to solve a problem in mathematics read it through and be sure you understand what is to be proved before beginning its solution; in translating a foreign language, read the passage through and see how much you can understand before consulting the vocabulary.

6. DO INDIVIDUAL STUDY. Learn to form your own judgments, to work your own problems. Individual study is honest study.

7. Try to put the facts you are learning into practical use if possible. Apply them to present-day conditions. Illustrate them in terms familiar to you.

8. Take an interest in the subjects taught in school. Read the periodical literature concerning these. Talk to your parents about your school work. Discuss with them points that interest you.

9. Review your lessons frequently. If there were points you did not understand, the review will help you to master them.

10. PREPARE EACH LESSON EVERY DAY. The habit of meeting each requirement punctually is of extreme importance. Plan to give each subject a definite time for its preparation.

Considering now the topic before us. The sources of waste in classroom work have been divided by Professor Bagley into two principal types; the first type includes those where the waste is due to failure to organize properly certain mechanical aspects of classroom activity; to this type he applies the term *routine factors.*

The second type includes those sources of waste which are due to failure to adjust the classroom activities to the constantly varying capacities, interests and responses of the students. To these aspects of school work, Bagley applies the term, *judgment factors.*

The routine factors include those matters that recur in approximately the same form from day to day and which can be advantageously systematized, organized and reduced to mechanical habits.

The judgment factors, on the other hand, are constantly varying, and require of the teachers constant alert exercise of judgment in order to avoid misdirected time and energy.

The routine factors with which the physics teacher is concerned are:

Starting right the first day.

Seating of students.

Handling of materials.

Attention to physical conditions.

Maintenance of order.

It is of material help for the teacher to have his work so planned that on the *first day* he can do three things—first, obtain a list of names of the students in his class and of their educational experience; second, give the class the general plans of the teacher for the course; and third, some definite instruction or information upon the work of the course. This may include a review of past related work or a conversational introduction to the new work, or both.

The seating of pupils in my own classes is done alphabetically, as my class lists are arranged the same way. This plan assists in becoming acquainted with the pupils and in noting absences, a vacant place indicating an absence. This renders unnecessary a roll call. If this saves three minutes for the class a day, it saves for each class of thirty pupils, ninety pupil-minutes per class day.

There is complaint of much waste of time in laboratory work. Conditions arousing criticism, however, may be prevented or overcome by setting definite tasks to be completed at a set time, in a specified manner, and expecting the pupils to keep up to the schedule. The pressure of the work, rather than the pressure of the teacher, should develop the habit of getting down to business promptly in order that the experiment may be satisfactorily completed within the allotted time.

A brief outline of the work at the start and some helpful questions at the end of the period, to clinch the conclusion of the experiment, may make the laboratory period as purposeful and concentrated as a recitation.

The laboratory notes should fall into a definite form as soon as possible. This will result in as much a saving for the teacher as for the pupil.

Another routine factor of much importance is that of giving *proper attention to the physical conditions* in the classroom or laboratory. This involves keeping the room at a proper *temperature,* from 68-72° F., in securing sufficient *ventilation,* and in providing the right amount of *lighting.*

Habitual attention of these three considerations—temperature, ventilation and lighting—will do much to eliminate distracting conditions about the student. He will be more efficient in his work as physical irritations are eliminated.

The fifth routine factor is the *maintenance of order.* If the first four routine conditions are secured, there will be little tendency to disorder, especially in subjects that provide definite tasks, of sufficient amount, variety, and interest to keep the attention occupied.

One source of waste of time and energy is the *dictation* by the teacher *of outlines,* syllabi, experiments, etc. These should be prepared with some form of duplicating apparatus, as the mimeograph.

This, properly, should be done by a clerk in the principal's office and in the best managed school it is so accomplished. If it cannot be done at the principal's office, the work should be at-

tempted by the teacher as it results in much saving of time on the part of pupils.

In arranging proper lighting, note that it should come from one side, the left if possible, or from a single source, to prevent conflicting shadows.

Turning now to the *judgment factors,* concerned with the planning of the work in our subject, one finds this considered by many writers under three heads. The first of these is often stated in the following form:

"The selection of subject matter in relation to varying social needs."

Thus, the subject of physics gained its greatest foothold in the schools as "Natural Philosophy," a study almost purely qualitative and which emphasized devices such as pumps and water wheels, that were of much value and interest to the population of that day.

In endeavoring to meet university requirements, the teaching of physics swung over to the extreme of quantitative measurements. It is now well back toward a position in which the qualitative aspect is given marked attention.

In fact, the leading question before the High School Conference of the University of Chicago next spring is to be upon the value and place of qualitative teaching in our schools.

One should lay out a program at the beginning of the year, assigning to each portion of the subject its proper amount of time, not forgetting to allow for reviews and examinations. This program once determined on should be followed closely. It will be necessary to abridge the work in some subjects. One is forced to the intensive study of fewer topics in carrying out the program above suggested.

This matter is dependent upon a second judgment factor, that of *the determination of relative values.* One must carefully consider the importance of the various topics to the individuals in the classes. I find that segregation simplifies this for me, since the individuals in my girls' classes have a different experience and outlook from those containing boys.

Our physics classes should have the applications of this science made clear, not only to the general facts and phenomena of nature, but to the industries and activities going on about them.

The special industries of a community afford many eye-opening opportunities for our physics classes. One teacher writes of visits to a blacksmith's shop, to the city waterworks, electric

light plant, to the hardware store, to study furnaces, silver plating factory, to the laundry to study dryer or extractor.

Attention should be called to the many opportunities in the home for illustrating physical facts and principles.

This leads to the third judgment factor, *the organization in terms of the learner instead of in terms of the subject itself.* This factor is the one that is receiving much attention at the present time. The teacher who ignores it is on dangerous ground, for it is as idle to shoot over the heads of those facing you in the classroom, as in the trenches of Europe.

Our work to be most successful must be determined by the needs, capacities and interests of the taught.

Thus this discussion ends where it began, with a consideration of the pupil, the one for whom the schools exist. His needs are of paramount consideration. How best to meet them is worthy the united attention and study of those in charge of the teaching in our school.

DIFFRACTION GRATING.

The completion by Professor A. A. Michelson, of the University of Chicago, of a diffraction grating for analyzing light, after nearly fifteen years of work, calls renewed attention to the mechanical difficulties of so delicate a process. The diffraction grating is made up of lines ruled by the point of a diamond on a smooth flat surface either of glass or of metal, and the efficiency of the grating increases with the number of the rulings and the accuracy of their spacing. A fairly accurate means of testing the performance of a diffraction grating is furnished by the separation of the two very slightly different colors of the two kinds of light emitted by glowing sodium vapor. If these can be just separated the grating is said to have a resolving power of one thousand. For this, a grating need have a ruled surface of only a small fraction of an inch.

The chief difficulty in the production of such diffraction gratings is that of ruling over a hundred thousand lines with exactly equal spacing. The position of any line in the grating should not be out by as much as a millionth part of an inch.

For such a high order of accuracy none of the ordinary appliances of the instrument maker are available. The essential feature of the machine which does such work is a very accurate screw, and the time required to produce this is roughly proportional to its weight; so that if it took two years to produce a good screw ten inches long it should take sixteen years if the screw were twenty inches long—as a matter of fact, the time taken was nearly fifteen years. The grating ruled by means of this screw has about nine inches of ruled surface with about one hundred thousand lines. The resolving power is something over half a million, about three times that of its predecessors.

GENERAL SCIENCE AND GEOGRAPHY IN THE HIGH SCHOOL.

By John Calvin Hanna,
Supervisor of High Schools for Illinois.

The writer is like the rest of mankind—he has had some flaws to pick in the scheme of public education; and, furthermore, he is like *half* of the rest of mankind in that he has had a proposed substitute for some things as they are.

Twenty years ago he became convinced that science study as it was in the high schools of that day needed a thorough over-hauling in the direction of adaptation to the needs and the capacity of those just promoted from the elementary schools.

This was the period when the more progressive high schools were quite generally escaping from the "fourteen weeks" system of science instruction. This was the good old plan according to which the youth read more or less interesting statements of more or less important facts and rules grouped in textbooks under the titles—"Physiology," "Chemistry," "Astronomy," "Physics," and then with the characteristic docility of childhood repeated these statements under the pumping process the next day. Some partly useful and fairly reliable information (the doctors will allow us to say "knowledge" in this connection), was accomplished in this way, and a few were led to go on—in the colleges and universities—and to do what was then beginning to be called research work, meaning laboratory work, under the inspired leadership of original and enthusiastic teachers of science.

Some of those who went on, back there in the eighties, returned, after graduation, to the high schools as science teachers, and, rebelling against the memory methods which had been in vogue, instituted laboratories and themselves performed in the awed presence of the youngsters—who meanwhile, with finger in book to mark the place, sat with bated breath—the various flashings and balancings and buildings and explosions that made some of the truths in the book seem a little more real.

This sort of thing, to be sure, had occasionally been done even earlier by some enthusiastic teacher, who "rigged up" apparatus for the purpose, but such an instructor had been considered a wonder, and oftentimes a crank. The ordinary instructor in that antediluvian period had conducted a lesson in any science just as he had done in history, for example. This method involved, on the teacher's part, the making of gentle inquiries as to what was

"said about" sulphuric acid or the feudal system, as the case might be, and, on the pupil's part, a repetition, with the rising inflection of certain statements on the subject, found on the printed page of "the book." Some people are cruel enough to assert that a considerable part of the science work done in many schools in the present day bears a family resemblance to this old-time and feeble substitute for real teaching; they even go so far as to say that this sort of thing is not confined to science but is found in English and history classes and the like.

Soon the performing of experiments by the teacher failed to satisfy and a demand came from the universities that a candidate offering, for example, physics as an entrance unit should have actually himself performed certain experiments in the laboratory. Gradually and less completely, this sort of requirement was extended to the other sciences offered for entrance.

The kind of work that was thus set for pupils of fifteen by the young and devoted science teacher, fresh from university laboratory, very naturally was oftentimes altogether beyond their capacity and, in fact, was quite largely a reproduction of the sort of thing that the young scientist had himself just gone through in his postgraduate labors for a master's degree. This ill adaptation of material and methods to the pupil was especially manifest in the biological sciences. In botany, for example, after the "list-of-definitions plus fifty-flowers-analyzed" period of education in this field, comes the "compound-microscope plus histology" period when the very young scientist, thrilling inwardly at the proximity of the instructor, who looked over his shoulder and pointed out the adjustments, peeped squintingly through the complicated arrangement of lenses and screws, and obediently said that he saw clearly "in the upper left portion of the field" just what the instructor told him plainly that he *should* see. Admirably unanimous, but oftentimes admirably inane and largely untruthful!

Such a way of dealing with these matters could not endure. Here and there rebellion arose against this system of science instruction. The writer was one of these rebels and his rebellion was also against the system of confining for a year the attention of the beginner in science study to the narrow limits of one or another of the fields into which scientific phenomena are, for many purposes, very properly grouped. That a beginner, led by the hand of his instructor over the great divide into the marvelous new world of "science," should be compelled, immediately, from the beginning, and persistently for a year to

confine his attention to "physiography" (which by this time had come to be an equivalent for "an intensified study of the processes and results of erosion") or to "botany" (which similarly had come to be an equivalent for "an intensified study of cell structure and arrangement"), or to "physiology" (which more or less completely had come to be an equivalent for "an intensified study of anatomical phenomena" or possibly of "bacteria and their work" or the like)—such an introduction is wholly inadequate, unfair and dulls the edge of interest.

Surely the youth on the borderland of the new world, standing on the pinnacle of his fresh enthusiasm, has the right to a look over the field, a general survey before he takes up chain and transit for a detailed survey, has a right to a "bird's-eye view" before he begins confining his attention to a "toad's-eye view" in some particular section of the garden of nature.

This feeling led to an early and persistent effort to develop a "Science I." course, to be given to first-year pupils, that should be free from these objections and that positively should fill these following conditions:

1. A course that should introduce the pupil to the observing of natural phenomena and the recognizing of natural laws in a manner adapted to the stage of his maturity, and likely to hold and maintain his interest and stimulate his growth.

2. A course that should serve the purpose of training him, not only to observe with accuracy, but to think to just conclusions from the data thus gathered.

3. A course that should furnish him, in this process, with information which he is likely to find useful in his daily life and which he may thus have stored in his memory, or which he may thus be trained, as he needs it, to go and get, with pleasure and ease and success, by further study or by consulting references.

4. A course that should prepare the way for any further systematic science study that may attract him or be needful.

5. A course that should conform to the Illinois state law which requires that all pupils below the second year of the high school and above the third year of school work shall study physiology and hygiene (including the nature of alcoholic drinks and other narcotics) for not less than four lessons a week for ten or more weeks of each year.

The experiment was wrought out in Oak Park, Ill., and occupied the loyal, devoted, enthusiastic, intelligent efforts of a series of teachers, extending over a term of twelve years, and

culminating in a "General Science" course (if it be safe to use that term in these controversial days!), or, if safer, an "Elementary Science" course. This course was in successful operation for years before any of the textbooks in "General Science" now on the market were issued.

The reason for referring to it here lies in the belief of the writer, from his observation of conditions in the high schools of the country, that we should come to a plan, in accordance with which all high school students should have a minimum of two science units, with the option of as many more, one or two or even three more units, as the resources of the school can offer and the inclination and need of the pupil demand.

This belief includes also the following points:

1.   That the first of these two required science units should be a preliminary view of the field of "science"—the broad field of science seen thus to be one great body of knowledge, to be attacked in one way and to be utilized in the actual affairs of life, to which in all its various fields, it is vitally related.

Such a preliminary view should, in the writer's opinion, include the first-hand study of selected phenomena to assist in making clear certain scientific principles, as these are manifested in *several* of the above-mentioned fields of science study—physics, chemistry and biological sciences—all so arranged and presented as to show the interrelation of these groups of knowledge and the relation of all of them to the real affairs of life.

The preface to a late high school text in physics begins thus: "Physics is the summary of a part of human experience. Its development has resulted from the fact that its pursuit has successfully met human needs. Hence, it is believed that the presentation of the subject in the secondary school should be the *expansion of the everyday life of the pupil* into the broader experience and observation of those whose lives have been devoted to the study. Human activity and progress, therefore, should be the teacher's guiding principle, and the bearing of each phenomenon and law on the interests of mankind should be clearly disclosed and emphasized."

Such a statement might very well be put forth as the controlling theory of *all* science study and should apply, with particular force, to the initial unit of work—first-year science.

A year spent thus—if the course be wisely framed, and if the teachers, in breadth of training, in sympathy of feeling and in skilfulness of teaching, are adapted to it—provides, better than

any other plan yet offered, an introduction to the new world of science.

It serves as a good working introduction to the way of thinking and doing which science study is mainly aimed to induce, namely, the habits—first, of accurately observing and intelligently recording phenomena; second, of following to logical conclusion by means of clear thinking these principles thus established; third, obeying in the conduct of life the rules of life thus established.

The test of this plan has been made and the results are convincing to everybody that has examined it carefully.

"General Science" in some form as the introductory unit has come to stay. The war over, the "project plan" will settle itself. A thoughtful examination of the statement made above will perhaps show whether this working out of a "Science I" course is an example of the "project plan" of framing a course, or whether it avoids that as a plan of organization.

2. One more question remains: What shall the *second* required unit be? It may very well be answered in a general way, that the selection of it should be as free as is possible within the limitation—first of the resources of the school as to what courses can be and should be offered; second, of the pupil's interest as awakened in the first year's "preliminary view"; third, of the demands made in the way of preparation for more advanced study or for the profession or occupation to be followed.

It should, moreover, in the writer's opinion, be, if possible, a year's work in one field and in its methods should offer a contrast to the first year's work in one particular, viz.: that it should be as thorough and extensive a study for a year in one field—chemistry, physics, botany, zoölogy, agriculture—as the proper limitations of the high school demand.

If the student can also spend a third year in the high school in science work, let that third year be another year's work in some one field, either the same as or another field than the one occupying his attention in the second year of his science study.

But for years to come, the tendency is likely to be in the direction of confining the science study, for a large number of pupils, to two years.

One of these then, it seems to the writer, should be the "General Science" or "Elementary Science" referred to and the other unit might be physics for a youth planning to take an engineering course, or chemistry for one planning a medical course, or one

of the biological units for one planning an agricultural course at the university, and, in general, should be determined, if possible, by the needs of the pupil in his coming years. This question as to the second unit is fairly easy to answer for the groups of students given as illustrations, but the big question remains in many communities: What should such second unit be for that large number of boys (and some girls) who are "going into business," and for that equally large group who "don't know what they're going to do"—but who are going to be intelligent, active and responsible citizens of the community in which they are to live?

The answer to this question is "Geography," the richest and fullest and widest of the sciences, the science that takes up the big problem of *Earth* and *Man* and so brings together, appropriately enough, the two streams of thought and work that have carried the young mind along for years.

Geography relates itself to every field of inquiry, to every field of thought, to every field of activity.

It involves a recognition of physical and chemical laws; it has its basis on astronomy and geology; it involves the problems of meteorology and agriculture; it has necessary relations, in both directions, as cause and as effect, to history; the problems of civics, economics, sociology, commerce—all are, in an important sense, problems of geography. Race problems, labor problems, taxation problems, military problems, transportation problems, health and sanitation problems, art problems, religious problems— all have their roots in the science of Earth and Man.

There is much of what the pupil of seventeen had in his work five years earlier which seems to have faded from his memory. Perhaps, a fairer way of putting it is that he has acquired a new point of view since he studied these fundamental subjects that are so vitally related to the life into which he is to be plunged in another year. Because of the acquiring of that new point of view, that youthful point of view, which never will be replaced by the childish point of view, it is worth while—nay, it is necessary—in a well-considered scheme of education, that the youth at this period of his life, before he attacks the specializing work that is to prepare him for his life's work (or at about the same time, if the system of specializing be allowed, as some are suggesting, to begin at least partially at the sixteenth year), at that most important time of his development, I say, it is worth while that he have an opportunity for a review—I know no bet-

ter word, though it may be misunderstood—of those matters which claimed so large a part of his attention in the elementary school, reading, grammar, arithmetic, American history, geography. Those can all be presented at this latter period in such a way as to command and hold the attention of the rapidly maturing youth of those last two years in the high school program.

One of these, American history, already has such a position, and by general consent in these later days is one of the four regular studies that a twelfth grade student should pursue.

The experiment with American history has proved a great success. No unit in the whole program of studies has won for itself greater confidence as being adapted to the state of the youth's development, as sure to rouse his interest, and challenge the best of his powers, and as of "practical" value in fitting him for the responsibilities and privileges so soon to crowd upon him as a citizen.

As for arithmetic, we all know that there is an immense feebleness in this regard among high school graduates; a weakness leading to sweeping conclusions as to the instruction in the grade schools in that subject. No doubt there is truth in the charge that arithmetic instruction needs improving. No doubt, there is shabby teaching of arithmetic in many places; no doubt, there is needed a better balancing of the time devoted to different parts of the field of arithmetic. But the apparent deficiency is, perhaps, largely due to the neglect of a review in the high school period. A half unit course might very well be prepared and required of all fourth-year pupils that would command interest, call for close and intelligent and thorough work, and fit for meeting the problems of his activities that are to follow upon the completion of his high school course. For a very large number of pupils in the smaller high schools, this half unit would be better than the solid geometry which they generally plow through.

The reading—and I mean both the rapid and accurate taking in of the meaning from the printed page and the intelligent, effective reproduction of that meaning in oral expression—the plain reading in high schools is generally very, very bad. This should be made more and more a part of the English curriculum in every good high school; it might very well amount to a full half unit thereof.

Here, also, is the place for the scientific study of grammar—which was beyond the eighth graders; and with a strong and sympathetic teacher the course may be made delightful as well as helpful.

Something has been attempted in various places with such reviews, reading, arithmetic, grammar, and without, in all cases, degenerating into a cheap and hurried preparation to pass an examination for a certificate to teach.

In the matter of geography, all these reasons apply with especial force. The field is so broad and the material so abundant; the interests involved are so manifold and the interest that may be aroused is so high, so keen, so enduring and so varied; the practical uses of this study are so plain and so convincing, that the proposition to place geography as a full unit—the second required science unit for a very large number of high school pupils—ought to receive the general and hearty support of school people everywhere.

STORIES.

"The difference between Fahrenheit and Centigrade thermometers *are* that on Fahrenheit zero begins at 32° and on Centigrade it begins at zero or 1°."

"Conduction of heat *is when a* iron bar is heated at one end it soon becomes heated all over by the heated molecules going along the iron till the end is reached."

TO AID RURAL TEACHERS IN SOUTH.

To assist teachers in southern rural schools in making their courses of study fit more closely with the farm and home interest of the children, the United States Department of Agriculture will shortly publish a professional paper, *Exercises with Plants and Animals for Southern Rural Schools.* This bulletin, No. 305, is in no sense a textbook but is designed merely to be a guide for the teacher. It provides work in studying and observing plants and animals for each of the first five grades. The subjects to be studied by the pupils under the direction of the teacher are arranged by months in such a way that the subject matter may be studied at the time of the year when it is most interesting to the children.

Some of the work suggested is to be done in the classroom but much of it is arranged for field trips by the class. In formulating the exercises, the author had in mind increasing the interest of the children in their regular lessons as well as in the activities in their homes, and training them in outdoor observation by having them study ordinary seeds, plants, insects and animals carefully, under the teacher's guidance. In this way the children are led to discover for themselves much of interest and value in Nature that escapes the casual observer.

DATA ON TEXTBOOKS IN THE BIOLOGICAL SCIENCES USED IN THE MIDDLE WEST.[1]

By O. D. FRANK,
Quincy, Ill., High School.

In order to find out what textbooks are being used here in the middle west in botany, zo-ology, biology, general science, physiology, physiography and agriculture, the committee who had charge of the Biology Section of the Annual Conference of the University of Chicago with Related Secondary Schools, asked me to ascertain the names of texts used in the above subjects, make analyses and charts of the first three mentioned to show data obtained and present them at the meeting.

In order to do this a questionnaire was sent to twenty-five high schools in each of the states of Illinois, Indiana, Iowa, Michigan, Missouri and Wisconsin. This questionnaire covered the following points:

1. Text used in botany, zo-ology, biology, general science, physiology, physiography and agriculture.

2. Subject offered as a whole or half year.

3. Number of girls and number of boys taking each subject.

4. Number of girls and number of boys in high school.

5. Name of teacher of each subject.

While the number of schools included is somewhat small they are rather broadly distributed over the six states concerned and it is believed that they are fairly representative. Answers were received from ninety-seven of the one hundred and fifty letters sent out.

The committee asked that an analysis be made of the four botany textbooks, the four zo-ology textbooks and the two biology textbooks most widely used. In making the analyses, each page of the text was studied and the part of the page devoted to each particular phase of the subject noted. This was reduced to percentage.[2]

AN ANALYSIS OF FOUR BOTANY TEXTBOOKS.

It will be noted from the chart that plant physiology, ecology and economic botany hold prominent places in the majority of the texts analyzed. The wealth of illustrations in each of the four texts is also notable.

---

[1]Presented at University of Chicago Secondary School Conference, April 16, 1915.
[2]The charts were made by Donald Steers, a student in the manual training department of Quincy High School.

The amount of evolution and taxonomy which occupied a very prominent place in the botany texts of a few decades ago has dwindled materially.

AN ANALYSIS OF FOUR ZO-OLOGY TEXTBOOKS.

Evolution and morphology are emphasized more in zo-ology than in botany. In zo-ology, as in botany, there is a high percentage of comparative physiology and of illustrations.

AN ANALYSIS OF TWO BIOLOGY TEXTBOOKS.

Here, too, as in botany and zo-ology, it is shown that the physiological and economic phases predominate, also the percentage of illustrations is large. May it not be that the large amount of physiology shown in the biology texts indicates a recognition of the fact that physiology represents the common meeting ground of botany and zo-ology, therefore the opportunity of the unification of these into general biology?

The titles and authors of the texts, together with the percentage of schools in which each is used are given below. The percentages are calculated in each case in relation to the total number of schools offering the subject. Eleven different textbooks in botany, six in zo-ology and two in biology were mentioned in the answers received.

BOTANY.

An Introduction to Botany, Bergen & Caldwell, is used in thirty-three per cent.
Four botany textbooks by J. M. Coulter[3] are used in thirty per cent.
Botany for Schools, G. F. Atkinson, is used in nineteen per cent.
A Practical Course in Botany, E. F. Andrews, is used in six per cent.
Plant Life and Plant Relations, J. G. Coulter, is used in four per cent.
Bergen's *Essentials* is used in three per cent.
Bergen's *Foundations* is used in three per cent.
Botany—L. H. Bailey, is used in two per cent.

ZO-OLOGY.

A Textbook in General Zo-ology, Linville & Kelley, is used in seventy per cent.
The Animals and Man, V. L. Kellogg, is used in ten per cent.
Animal Studies, Jordon, Kellogg & Heath, is used in ten per cent.
A Textbook in Zo-ology, G. W. Herrick, is used in five per cent.
Animal Forms, Jordon & Kellogg, is used in three per cent.
Zo-ology—P. P. Colton, is used in two per cent.

BIOLOGY.

Essentials in Biology, G. W. Herrick, is used in sixty per cent.
Elementary Biology, Peabody & Hunt, is used in forty per cent.

---

[3] In a number of instances the person answering did not designate which of J. M. Coulter's texts was being used. *Elementary Studies in Botany* being named most frequently it was the one analyzed.

BIOLOGY TEACHING IN INDIANA HIGH SCHOOLS.

By C. E. Montgomery,
Bloomington, Indiana.

There has long existed a feeling that the biology work in Indiana high schools has not been accomplishing all the good claimed for it. Other investigations[1] tend to support this opinion but none apply directly to the Indiana field. It is not only hoped that this study will point out more vividly some of the glaring weaknesses in this work in Indiana, but that it shall also serve to awaken in the teachers a desire for a change. Many teachers feel that they are helpless and that school officials hold the sources of relief. This is to be admitted, yet teachers can do very much to alleviate the situation if they realize the condition of affairs and all work in conjunction toward a definite end.

One hundred fifty sets of the following questionnaire were sent to as many commissioned high schools of the state and sixty-eight were returned, more or less carefully answered. The writer wishes to thank all those who co-operated in this work, both the friends who helped with the questionnaire and the teachers who answered.

Fellow Teacher: With the consent of State Superintendent Greathouse, I ask you to fill out the following blank, carefully and promptly, and return the same to me, Charles E. Montgomery, Bloomington, Indiana.

To Teachers.

1. Name .... School ....
2. Your normal school or college and degree ....
3. Was your major work in botany or zo-ology?....................
If not, what? ....
4. Amount of preparation in subject matter of botany and zo-ology
....
5. What professional preparation for teaching botany and zo-ology have you made and where? ....
6. How long have you taught botany and zo-ology? ....
7. What other subjects do you teach? ....
Classes per day? ....
8. State your preparation for teaching agriculture in the high school
....
9. How do you spend summer vacations? ....

The Course.

1. Year in which botany is taught .... Zo-ology ....
Length of course in botany .... Zo-ology ....
2. Year in which you think botany should be given ....
Zo-ology ....
3. Is botany required or elective? .... Zo-ology? ....
4. Time devoted to laboratory work per week ....
To recitations ....

[1]Fink, Bruce—*Botanical Instruction in High Schools of Ohio;* Hunter, W. G.—School Science and Mathematics, 1910; Caldwell, O. W.—School Science and Mathematics, 1909.

5. Amount and kind of field work ....

....

6. Does your course emphasize the practical side of botany and zo-ology or does it follow purely scientific lines? ....

7. Is your course modeled after the state course, a college course, a textbook or your own plan? ....

8. Is your course satisfactory to you? .... If not, suggest remedies ....

9. Is agriculture taught separately or with botany course?............

10. If taught separately, in what year? .... Is any science required before it? .... What? ....

11. What botany text and manual are used? ....

12. Number of library books in botany ...., zo-ology ...., agriculture .... Are they texts or reference books? ....

13. State value and adequacy of laboratory equipment ....

....

14. What value do you attach to botany and zo-ology in high school?

....

....

15. On back of this sheet (top half) write brief outline of your course by six-week periods.

16. On back of this sheet (lower half) make suggestions as to what you think biology teaching in Indiana high schools needs most.

SCHOOLS REPLYING TO THE QUESTIONNAIRE.

1. Alexandria	24. Greenwood	47. Portland
2. Auburn	25. Hartford City	48. Princeton
3. Bedford	26. Hope	49. Roachdale
4. Bloomfield	27. Huntington	50. Rockport
5. Bloomington	28. Hammond	51. Salem
6. Brazil	29. Kentland	52. Scottsburg
7. Brookston	30. Kewanna	53. Shelbyville
8. Brookville	31. Jeffersonville	54. Sheridan
9. Charlottesville	32. LaFayette	55. Shortridge (Ind'p's)
10. Cherubusco	33. Ligonier	56. Spencer
11. Crawfordsville	34. LaGrange	57. Spencerville
12. Cayuga	35. Lebanon.	58. South Bend
13. Delphi	36. Leo	59. Sullivan
14. Decatur	37. Laporte	60. St. Paul
15. East Chicago	38. Madison	61. Tell City
16. Elwood	39. Marion	62. Terre Haute
17. Franklin	40. Martinsville	(Garfield)
18. French Lick	41. Mitchell	63. Veedersburg
19. Fort Wayne	42. Montmorenci	64. Washington
20. Goodland	43. Mulberry	65. Warren
21. Goshen	44. Milford	66. Worthington
22. Greencastle	45. Noblesville	67. Winchester
23. Greensburg	46. Oakland City	68. Winnemac

Only the commissioned high schools were included in this study because it was assumed that conditions in the lower schools would be no better.

THE TEACHER.

The importance of the teacher in any line of work can hardly be overestimated. However, there is a great difference between a real teacher and one who puts in time. A great many teachers take into consideration in their work only one factor, the subject

matter. Leaders in education have long since recognized that an efficient teacher understands the pupil as well as the subject matter. General methods of teaching do not fit the high school of today. The more divisions into special departments demand a more special training in methods. The North Central Association is now requiring that all schools of that organization employ teachers who are equipped in special methods as well as special subjects.

Recently school authorities began demanding that teachers entering their schools be graduates from some standard college. It was generally desired that such teachers be majors in the work they were asked to teach, but this was and is today adhered to, only in the larger schools. Of the sixty-eight teachers reporting on this questionnaire, thirty-six hold bachelor degrees, and nine are masters. Seventeen are normal graduates and the remaining six did not give their college standing. Although this is a small number of schools to be basing any statements upon, yet these figures are significant in that they show the tendencies in secondary schools. This group is a fair representative of the commissioned schools of Indiana and whatever conditions are found here will be about the best average that can be estimated in this state. These figures show that over ninety per cent of the teachers handling biology have the bachelor's or normal graduate standing. If the schools can raise their standard of scholarship to this extent, this certainly demonstrates that they can improve in other lines as well.

The increase in preparation of high school teachers has done much to improve the efficiency of the work, but the notion that a college graduate can teach one thing as well as another, regardless of his special training, has caused much distress in education. The teaching of the biological subjects is among the greatest sufferers from this dilemma. Twelve of the sixty-eight teachers represented in this report are majors in botany; five in zoology; four in history and economics; five in English; four in mathematics; eight in physics; seven in chemistry; four in agronomy; four in German and Latin; two in philosophy; two in education; two in agriculture; seven did not report. So far as botany is concerned, these data show less than twenty per cent of those intrusted with the work are primarily interested in it. This probably means that a larger part of the botany in our high schools is not done because the teachers see the value of it, but because some higher authority has willed it. This and the fact that the

efficiency of the teaching force in lower graded high schools is very much decreased, both in preparation and numbers, are weighty points in accounting for the deficiency in biology work.

On account of the meager report on zo-ology it is better to dispose of it all at once. Five teachers majored in zo-ology; twelve schools are offering courses in it; five give one-half-year courses and six one-year courses. The other one did not report. This evidence seems to indicate that zo-ology has very little part in secondary education. There was not enough evidence offered in the report to determine any reasons for this condition.

Since so few teachers who are doing botany work are majors in that subject, one may rightfully ask, how much botanical training do these teachers usually have? Eight teachers have had less than one year of college botany; fifteen from one to two years; three from two to three years; and fourteen from three to four years. Twenty-six others gave general science and biology for their scientific training but did not signify how much nor where the emphasis was. It is quite generally conceded that to handle high school botany in anything like an efficient manner, one must have at least two years of college work in this line. As the above facts show, just about twenty-five per cent of the botany teachers in Indiana's largest and best high schools can meet such qualification. The percentage in the smaller schools, no doubt, is very much lower. Anyone acquainted with the school system of this state can fully realize that it is impossible to have a major teacher in each department of the high school. However, the public has the right to demand that teachers in charge of any line of work shall measure up, in a fair degree, to a certain standard and school boards should not be permitted to place any teacher in a position for which he or she is incompetent. Such a rule would mean a broader preparation and less specialization for teachers in the smaller schools which would not be a backward step at all.

There is yet another side of the story. The botany major goes out into the high school to teach botany with as little notion about what to teach and how to teach it as one much less qualified. The work given in the colleges and normal schools is so different from that in the high schools that each teacher must resort to his own ingenuity and secondary school literature for materials and methods.

Of these sixty-eight reports, forty-nine teachers say they have had no professional training in this subject and nineteen give from twelve to twenty-four weeks in learning how to teach bot-

any. These people do not understand the high school pupil and yet they must fit a course of study to him. The results are showing up in the fact that a smaller proportion of pupils is taking high school science today than ten or fifteen years ago. The colleges and normal schools that are endeavoring to help this situation are at a variance, consequently there is no unity of effort from this source. Many students and teachers have a feeling that it is a waste of time to do any work in special methods. The departments of education in our progressive colleges and universities are making strong efforts to remedy this condition, but at the present time the effects seem almost imperceptible.

School authorities always place a great deal of stress upon a teacher's experience. This report shows forty-two teachers with over two years' experience. The other twelve who answered had less than one year. If this percentage should hold in the lower schools and experience means very much, it seems that this work ought not suffer more than any other line in the high schools. Students of educational problems are now realizing fully that in many cases experience means stagnation. Teachers become so accustomed to follow the lines of least resistance that all avenues to progress are closed. This is what is happening to many of the experienced biology teachers in Indiana. Young and progressive teachers who are imbued with a spirit of growth can be trusted to do better work than many of those with long experience, and little education.

Many teachers offer as an excuse for poor biology work, that they have too many subjects to handle and too many classes per day. According to this study, five people teach botany only; eighteen, botany with one other subject; twenty-one, botany and two other subjects; eleven, botany and three other subjects; and six, botany with four other subjects. One teacher reports two classes per day, four have three classes, sixteen have four classes, seventeen have five, fifteen have six, six have seven and one teacher handles eight classes each day. No one expects a teacher having four subjects to do as good or better work than the teacher with one or two. However, the condition that usually arises in this connection is that the teacher stresses one subject and just passes on the others. This is unjust to the pupil and the instructor, who, no matter how heavy the burden, should properly apportion the time and effort so that no weak spots in the work could appear. Most teachers accept their position knowing what work they are to do; therefore, they should not

complain of overburdens but strive to be just through and through.

On account of the present agitation for agriculture and because of its close relation to botany, it was regarded worth while to learn the feeling of biology teachers toward it. The preparation of this group of teachers is shown by the following figures:

Fifteen report some agricultural training, mostly less than one year; thirty say they have worked up the course themselves, had experience on the farm or are managing a farm. The remaining ones have had no training at all. This report brings to light an old fallacy, namely, the idea that one can work up a course of study alone. This notion has done much to weaken the effects of science teaching as a whole. A preparation for science teaching of any kind without the aid of a college or normal training can only be fragmentary and very narrow.

These self-made teachers are out of date and should be. Our schools do not want teachers who have only a scrappy, irrelevant bit of common facts, but those who are broad and understand the organization of the subject in hand. It is sincerely hoped that the agriculture work that is now being urged so strongly upon the public schools will not fall victim to a corps of these home-prepared teachers. There is no reason why agriculture should not advance with a sturdy, healthy growth if the administrators will only try to profit by the present conditions of biology.

The summer vacation presents the best opportunity for active teachers to add to their store of material and advance to a higher plane in the profession. This report shows that over sixty-five per cent of this group of teachers spend their summers at school or traveling. This displays a good spirit and one that should be encouraged by school authorities more than it is. It would not be at all improper for school boards to make increases in salary partly dependent upon the use teachers made of their summer vacations.

THE COURSE OF STUDY.

With well-prepared teachers to administer it, the end results of biology work may yet be poor if the materials used are insignificant or badly organized. The prevailing opinion in regard to the arrangement of biological work has been and is, that the teacher should select and organize the materials in whatever manner seems most expedient to this or that particular case. As a result, one finds the organization and administration of botany

and zo-ology courses in Indiana high schools are extremely varied.

Botany is offered in all this group of schools except three. Forty-eight are giving the work in the freshman year, eight in the sophomore, and two each in the junior and senior years. Fifty-four schools are giving one-year courses while only six are giving a half year's work. Forty require botany for graduation and seventeen make it elective. If these figures are representative of the true situation, in Indiana, botany is a first-year science. This means that the course of study must be suited to ninth-year pupils[2]. However, from these reports, twenty-five teachers prefer botany in the first year of the high school, twenty-two in the second, seven in the third, and six in the fourth. This, coupled with the facts above, places botany early in the high school course, which seems to be a general feeling all over the country.

A large majority of the schools are favoring a full year course rather than the half year. This is shown by the foregoing figures. From the fact that almost two-thirds of these schools require botany for graduation, one of two things seems evident; either school authorities consider botany very much worth while or it is the cheapest and most easily handled science for high schools. The question before students of education is not is botany of any value but is botany doing the good it can? It is sincerely hoped that school authorities are not putting botany in the schools because it costs less to install and operate than other sciences.

The arrangement of laboratory and recitation work has caused a great deal of contention. Twenty-one of these schools give more than half their time to laboratory work. Forty-five others give less than half time to laboratory study. Of the forty-five, twenty-seven have two laboratory periods per week, fifteen have one and three have none. In smaller schools no doubt the amount of laboratory work will be found much less on account of the difficulties in equipping. Botany work without laboratory study is not science but rather a dry, superficial piece of literary discussion. The laboratory work should be the core of the course, while discussions and recitations should supplement and broaden. Nothing can put life and interest into a botany course more than the actual handling of live plants, both in the laboratory and in their natural surroundings.

[2]Fink, Bruce—*Botanical Instruction in High Schools of Ohio;* Hunter, W. G.— SCHOOL SCIENCE AND MATHEMATICS, 1910; Caldwell, O. W.—SCHOOL SCIENCE AND MATHEMATICS, 1909.

Field work properly done is one of the best sources of enthusiasm that can be used. It matters not that the class should always be taken to some curious or wonderful scene. A trip to the flour mill, a factory, or any place bearing on the work in hand, adds much to the meaning of the work. Fifty-one schools in this report are doing some kind of field work. Some make frequent trips, others go out on rare occasions. Trips for laboratory specimens, classification, and ecological studies are the predominant types. If credit is to be given for field trips, they should be carefully outlined and then written up by the pupils. It seems unfortunate that teachers of the rural districts do not take more field trips. Lack of time seems to be the most general excuse, but more real botany can often be gotten from a few minutes' study of a weed patch than a whole week spent on this and related topics in recitation.

More practical botany has been the cry of the last decade. It seems that the schools are attempting to respond. Thirty-five are offering courses that are of a practical nature, nineteen emphasize both practical and scientific work, and three try to make their work purely scientific. From data of this sort it is hard to determine what is meant by "practical botany." To very many it signifies an agricultural tint or some other related phase, to others, perhaps, more of a study of economic uses of plants, and among different groups and individuals the meaning is widely varied.

In not a few cases, practical botany has been taught from a textbook without including laboratory work or outside observation. In fact the expression, "practical botany," has in many instances become void of meaning and is merely a screen behind which nothing is hiding. On the other hand, there is a place for such work in the botany course and it should be included. It can be made a very vitalizing part of the work when administered with the proper setting and in the right amount, but if it is not used with careful discretion it becomes a damaging rather than a helping addition.

Fifty-seven schools reported on the types of courses of study they are using. Fourteen are following the State course; seventeen, their own plan; seven, the textbook; one, a college course; and eighteen, combinations of the above. This certainly indicates that the standard course in botany is not very popular in Indiana. These figures show at least one thing and that is that there is very little co-ordination of botany work among the various schools.

When a teacher once becomes satisfied, the spirit of progress seems to disappear. Of the fifty-four schools that answered to this inquiry, nineteen are pleased with the work offered, and ten of these have had less than one year's work in college botany. The majority of those reporting, however, are hopeful for a change and feel a great need for an awakening in biological teaching. As to the relief of the present situation, fifteen suggest more laboratory equipment; twenty, more time for laboratory work; two, more library facilities; two, putting the course later in the school work; and one each suggests a full year's work, smaller classes, adjusting the laboratory to freshmen, more evolution, more field work, a preparatory course, less textbook work, making work easier, and substituting agriculture and horticulture for botany. These suggestions are those generally given in answer to a question of this kind and with two exceptions would surely add a great deal toward the efficiency of botanical instruction. However, high school pupils are not needful of much more evolution as it is given, nor would the botany situation be very greatly helped if agriculture or horticulture were substituted instead.

Fifty-one schools answered in regard to teaching agriculture with the botany. Twenty-two are combining the two and twenty-nine are not. The fact that over one-third of these schools are placing botany and agriculture together shows to some extent the shortage of interest and appreciation of these two subjects. All the high school sciences seem to suffer from one misconception. The name is the most important thing and the content may be anything. Botany and agriculture have very much material in common but that should be no reason for breaking up the organization of either subject. Science courses can be greatly strengthened by a closer correlation, but a mere mixing of materials can not be considered correlation.

Since the adoption of Indiana's textbook law, four botany texts have been selected for use in the high schools. Their distribution among these schools is as follows: Four schools use Coulter's *Textbook of Botany*, eight use Coulter's *Plant Life and Plant Uses*, sixteen use Andrews' *Practical Course in Botany*, and twenty-three use Bergen and Caldwell's *Practical Botany*. Other texts and manuals mentioned by one or two schools are: Warren's *Elementary Agriculture*, Hunter's *Biology*, Payne's, Sharpe's, and Meir's *Manuals*. The question that would seem proper here is, are these texts each suited to the particular needs

of the schools that use them, or to the fancies of the teachers who have adopted them?

The library is an asset to botany work that can be used very profitably. Fifty-two of these schools reported libraries, two have over four hundred volumes; one, three hundred; one, two hundred; two, one hundred fifty; seven, from fifty to one hundred; thirteen, from twenty-five to fifty, and twenty-six, below twenty-five volumes. It does not always mean that the largest number of books makes the most workable library. There should be a number of reference books on the shelf of a technical nature for the teacher's private use, but for the pupils, sets of the best texts and of books treating special topics are the most satisfactory.

The laboratory is the most essential feature in the material equipment for botany work. Thirty-five teachers reported on this point as follows: One has equipment to the value of three thousand dollars, one to seventeen hundred, one to fifteen hundred, four from five hundred to one thousand; nine from two hundred fifty to five hundred, and nineteen from ten to two hundred fifty. Twenty-nine reported their equipment not adequate and twenty say theirs is good enough. Laboratories, like libraries, are not necessarily best equipped when fitted with an abundance of expensive apparatus. Some apparatus is essential, but because of lack of funds teachers should not be without the laboratory. It must be remembered that the most important and least expensive part of the laboratory equipment is supplied by the big out-of-doors. Much of the mechanical apparatus can also be furnished by the ingenuity of the teacher. School people cannot get too far from the old idea that botany is a manipulation and study of apparatus and books.

The permanent values that the teacher sees in a study of botany determine very largely the nature and quality of work done. Some teachers gave more than one aim in their replies, so that the following figures represent a catalog of the number of times the points were mentioned. Twenty instructors think botany should prepare for some other science, nine say it trains observation, eight think it brings the child closer to nature, fifteen feel that it is very important, nine say it is educative, six get appreciation from it, five say it gives valuable knowledge, one thinks it can help solve sex problems, three say it gives a scientific training, and three feel that it is of no value as it is taught. A few of these answers indicate clearness and are to the point, while

the others simply show that the teachers have no definite notion of what botany may do for the child. To say that it is important or educative is not enough. The instructor must understand clearly and distinctly the things[3] that make it so, else the whole organization can only be superficial and the accruing results are the mere facts recorded in the teacher's class book that the pupils have passed the work satisfactorily.

One of the most difficult problems that the teacher must face when undertaking botany work is the selection and organization of materials for class use. There are several type courses outlined in botanical literature but the teacher can seldom find one to his liking. Forty-five teachers sent in outlines of their work as it is offered by six-week periods. Thirty-three are giving the structure and functions of organs of seed plants; thirty-one, the evolution series; sixteen, classification; fifteen, forestry and tree classes; nine, ecology; seven, agricultural materials; seven, pollination; five, soils; four, weeds; three, horticulture; three, reproduction; two, plant industries; and one each offers the food groups, botanical chemistry, theory of evolution, survival of the fittest, and mitosis. This is a wide field to be covering in one year's work, yet with the exception of the last three all have a legitimate claim to a place on the program. Two things stand out pre-eminent above the rest, the structure and functions of seed plant organs and the evolutionary series. If these were the only topics treated, it is at once evident that the work cannot be handled with slight preparation.

Of these outlines that are definite enough to follow, ten begin with trees and their leaves, seven with leaf study, eight with whole plants, four with the lower groups, three with roots, two with flowers, two with seeds, and one each with botanical chemistry, soils and plant environment. The order of the sequence of topics is just about as varied as are the beginnings. This evidence shows the absolute variation in the botany courses and clearly indicates no correlation among the several schools. Most schools are agreed, however, upon beginning with seed plants or some part thereof and ending with a treatment of the evolution series.

One factor that seems to bear no little weight upon this situation is the topic of "local needs." No one will deny that the community in which and for which the school exists should have the first claims to the school's product. "Local needs"

[3]Lloyd & Biglow—*Teaching of Biology;* Ganong—*Teaching Botanist.*

should determine to some extent the materials of the course but why the whole sequence of topics should be so completely upset is a question that deserves a fair consideration. A careful diagnosis of this argument usually reveals the fact that the teacher is pursuing some particular hobby. Many teachers who use this kind of argument would teach the same course in two entirely different communities.

Many persons scoff at the mention of a standard course in botany and other biological sciences. In Indiana and all over the country, this miscellaneous plan has been tried to the limit. Some good has resulted, indeed, but the work is not keeping pace with other less vital subjects that are thoroughly organized and standardized. A standard course in botany would not mean one that is air-tight and would permit of no variation; but a clearly framed set of topics arranged in a definite order. This should neither curb the teacher's individuality nor disregard the needs of the immediate community. The big, underlying principles that make the subject universally worth while, however, should not be deposed by a hopscotch mixture of indiscriminate facts. A definitely organized course would also relieve those pupils who are obliged to change from one school to another of much embarrassment and loss of time. The time is now at hand when science teaching should turn away from these fabulous community differences, and careless, aimless methods into clearly directed paths.

CONCLUSIONS.

While botany in Indiana high schools is not satisfactory, it would not be fair to say it is an absolute failure. Much good is being done in many quarters in spite of the defects. All the blame for inefficient work should not fall upon the teacher. Since more than eighty per cent of these teachers are not primarily interested in botany, it devolves upon the administrative officials to be more particular in their selection of instructors. Superintendents should insist that their teachers be more thoroughly prepared and any school official who suggests that a teacher can handle a subject with no more than one year of preparation fails to administer the justice owed to an innocent public. Teachers should not only understand the subject matter, but they should also know the aims of the work and the best methods of teaching. The "local needs" and "practical botany" ideas are being very much overworked. Although they should be very carefully considered in the making of a course, yet they should not be per-

mitted to destroy the organization and essential purposes of the subject.

Laboratories need a great deal of attention. Enough apparatus should be supplied to enable the classes to do at least a minimum amount of work with plants and plant experiments. Libraries should also be equipped sufficiently to permit all the supplementary reading that time will allow. But one thing must be remembered, and that is that the whole course should be based upon a study of plants actually alive.

Botany courses should be standardized and placed upon the same level as other high school subjects. School authorities should not accept botany as a secondary science until it reaches a fair degree of efficiency.

This study shows that botany needs a close and rigid supervision. A free co-operation of school officials and teachers would soon relieve the present situation of botany and the values of the subject would be cleared of any shadow of doubt.

FARMERS' INSTITUTES MORE POPULAR THAN EVER.

Both the number of farmers' institutes held each year and the attendance at these meetings is steadily increasing, according to a report on farmers' institute work which has just been published by the United States Department of Agriculture as *Bulletin No. 269*. During the fiscal year ending June 30, 1914, the report states, 25,238 of these institutes were held throughout the country, with a total attendance of 3,656,381. This is an increase in attendance of twenty-six per cent over that of any previous year. On the other hand, the expense of conducting the work was nearly $63,000 less than last year, the total cost for the fiscal year ending June 30, 1914, being $447,896.51.

The farmers' institute organization conducts its work under many different forms so that it is almost impossible to summarize its activities briefly. For example, in addition to the ordinary meetings, there were movable schools in thirteen states which had a registered attendance of 112,498 different people. Field demonstration meetings were also held in fifteen states, although no record of the attendance was kept. Special railroad trains were organized in seventeen other states for the purpose of giving lectures and demonstrations. A detailed analysis of this work, showing the number of different kinds of meetings in each state, the attendance, and the duration of each, is contained in the bulletin already mentioned. This bulletin also contains a number of notes on agricultural extension work of a similar nature in foreign countries.

MATHEMATICS AND EFFICIENCY IN SECONDARY SCHOOL WORK.

By Robert E. Moritz,

University of Washington, Seattle, Wash.

For the purpose of this discussion I shall accept the definition of efficiency formulated by Ex-President Eliot of Harvard University. "By efficiency I mean effective power for work and service during a healthy and active life. This effective power every individual man and woman should desire and strive to become possessed of; and to the training and development of this power the education of each and every person should be directed. The efficient nation will be the nation made up by aggregation of individuals possessing this effective power; and national education will be successful in proportion as it secures in the masses the development of this power and its application in infinitely various forms to the national industries and national service."

Now if efficiency means effective power for work and service, then it is clear, education will be efficient in the degree in which it develops the powers of the individual. First of all there must be a proper development of the bodily senses and organs. The time for this is early youth, the first years of schooling should therefore be more largely directed to the training of sight, smell, hearing, taste, and touch. Next to this comes the mastery of the primary school arts—reading, writing and the elementary number combinations. Simultaneously, the child will, of course, become acquainted with its immediate environment and through observation and memory properly directed it will come in possession of a body of facts and experiences which are essential to its further development.

In the second stage of the educational process the emphasis should be shifted from the training of the bodily functions to the mental processes, to esthetic appreciation, and, incidentally, to the acquisition of a large body of facts. This also is the time for laying the foundations of a moral character. The grammar grades are the vantage period for forming correct and useful mental habits. It is also the time when the child must more completely orient himself in the world of his experience, and for this purpose a more extended knowledge of space and number relations becomes indispensable. The study of form, known as observational geometry, and the number processes, known as arithmetic, should therefore occupy a considerable portion of the child's time and attention during this period.

We now come to inquire into the part which secondary education, the high school period, should play in the development of the child's powers. There are those who hold that true efficiency demands that during secondary education the emphasis be shifted from the general training of the mental powers to the accomplishment of special tasks, to matters immediately connected with the problem of earning a livelihood. This is essentially the view of the vocationalist. No one will deny that vocational training has its place, and I am one of those who should be glad to see vocational schools of all sorts multiply tenfold in every large center of population to equip better the millions who must be the hewers of wood and carriers of water in the world's work. Better far to have the boy and girl efficiently trained to perform his or her share of the world's work, no matter how humble a share that may be, than to be cast out on the turbulent waters of life's sea without chart or compass at the tender age of fourteen to survive as best he may or be submerged by the waves of a merciless commercialism.

But vocationalism must not encroach upon the sphere of secondary education as a link in that chain of agencies whose distinct mission it is to prepare individuals for the larger activities of life. To cope with the perplexing problems of our complicated industrial system; to understand the nature of our highly organized financial and commercial institutions; to have an active part in the betterment of society; to comprehend the principles of physical, chemical and biological science upon which our physical well-being depends, and to assist in the further subjugation of the forces of nature for the service of man; to grapple with the endless social, economic and political problems of a democratic state; to contribute in any way to the world's progress and culture, or even to be merely an intelligent citizen and voter in a great world state like our own; all this demands a far greater development of the qualities, abilities, faculties and functions of the human body, mind and soul, than is afforded by the most efficient grammar school course of our public school system.

Secondary education, to be truly effective, must therefore concern itself primarily with the further training of the powers of the individual. Of course such training will go hand in hand with the further acquisition of knowledge, but this knowledge will be largely of underlying laws and principles rather than specific facts. Specific facts are important in secondary instruction only in so far as they are necessary to an understanding of fundamental

laws and principles. Subjects of study which accomplish neither one nor the other of these two ends, which neither develop the student's powers and assist in the formation of useful mental habits, nor furnish a body of fundamental principles and relations which will aid in the comprehension and interpretation of the world's multiform phenomena, have no rightful place in the curriculum of the high school. It follows that the most valuable subjects of high school instruction will be those subjects which combine in the highest possible degree both of these ends. The young man or woman who leaves the high school with his powers fully developed, with useful mental habits firmly established and equipped with a knowledge of the great laws and principles which govern the sciences, the arts, the industries, which underlie human society, institutions and government—a person thus equipped will easily possess himself of any special body of facts necessary in the solution of any given problem or the accomplishment of any given task. It is a trained mind stored with a knowledge of great fundamental principles that make it possible for a Wilson to leave the teacher's desk to assume the leadership of a great nation at the time of a great national crisis.

We are now in a position to understand why the study of mathematics must necessarily occupy a large place in secondary instruction. It is not because the theorems of geometry or the rules of algebra as such are of any great value to the average high school graduate, though it will be admitted that they are indispensable to every scientific pursuit and to countless occupations and professions. The mere knowledge of the Pythagorean triangle relation or the binomial theorem is probably of less immediate value to the average graduate than the knowledge of how to sharpen a knife or to sew on a button. But as an exercise in fundamental thought processes they are invaluable to every individual, no matter what his ultimate work in life may happen to be.

Let me first enumerate those powers of the mind in the development of which it is generally assumed mathematical studies have little or no place. They are observation, comparison, memory, induction, generalization, and imagination. Yet Sylvester, the most brilliant pioneer of university education in America, went on record by saying, "There is no study in the world which brings into more harmonious action all the faculties of the mind than does mathematics." "Mathematics is unceasingly calling forth the faculties of observation and comparison, one of its

principal weapons is induction, it has frequent recourse to experimental trial and verification, and it affords a boundless scope for the exercise of imagination and invention." That mathematics has no part in generalization is also controverted by no less an authority than John Stuart Mill. "That the mathematics do not cultivate the power of generalization," he says, "will be admitted by no person of competent knowledge. The generalizations of mathematics are, no doubt, a different thing from the generalizations of physical science; but in the difficulty of seizing them, and the mental tension they require, they are no contemptible preparation for the most arduous efforts of the scientific mind." "To perceive the mathematical laws common to the results of many mathematical operations, even in so simple a case as that of the binomial theorem, involves a vigorous exercise of the same faculty which gave us Kepler's Laws, and rose through those laws to the theory of universal gravitation."

I will close the issue as to the part which mathematics has in the development of the first group of powers with an extract from an article by Edward Olney in Kiddle and Schem's *Encyclopedia of Education*. "It has been asserted," says Professor Olney, "that the power of observation is not developed by mathematical studies; while the truth is, that from the most elementary mathematical notion that arises in the mind of the child to the farthest verge to which mathematical investigation has been pushed and applied, this power is in constant exercise. By observation, as here used, can only be meant the fixing of the attention upon objects (physical or mental) so as to note distinctive peculiarities—to recognize resemblances, differences, and other relations. Now the first mental act of the child recognizing the distinction between one and more than one, between one and two, two and three, etc., is exactly this. So again, the first geometrical notions are as pure an exercise of this power as can be given. To know a straight line, to distinguish it from a curve; to recognize a triangle and to distinguish the several forms—what are these, and all perceptions of form, but a series of observations? Nor is it alone in securing these fundamental conceptions of number and form that observation plays so important a part. The very genius of the common geometry as a method of reasoning—a system of investigation—is, that it is but a series of observations. The figure being before the eye in actual representation, or before the mind in conception, is so closely scrutinized, that all its

distinctive features are perceived; auxiliary lines are drawn (the imagination leading in this), and a new series of inspections is made; and thus, by means of direct, simple observations, the investigation proceeds. So characteristic of common geometry is this method of investigation, that Comte, perhaps the ablest of all writers upon the philosophy of mathematics, is disposed to class geometry, as to its method, with the natural sciences, being based upon observation. Thus we proceed to consider the whole range of human faculties, and find for the most of them ample scope for exercise in mathematical studies. Certainly the *memory* will not be found to be neglected. The very first steps in number—counting, the multiplication table, etc., make heavy demands on this power; while the higher branches require the memorizing of formulas which are simply appalling to the uninitiated. So the *imagination,* the creative faculty of the mind, has constant exercise in all original mathematical investigations, from the solution of the simplest problems to the discovery of the most recondite principle; for it is not by sure, consecutive steps, as many suppose, that we advance from the known to the unknown. The imagination, not the logical faculty, leads in this advance. In fact, practical observation is often in advance of logical exposition. That the imagination, and not the logical faculty, leads in all original investigation, no one who has ever succeeded in producing an original demonstration of one of the simpler propositions of geometry can have any doubt. Nor are *induction, analogy,* the *scrutinization* of *premises* or the *search* for them, or the *balancing* of *probabilities,* spheres of mental operations foreign to mathematics. No one, indeed, can claim pre-eminence for mathematical studies in all these departments of intellectual culture, but it may, perhaps, be claimed that scarcely any department of science affords discipline to so great a number of faculties, and that none presents so complete a gradation in the exercise of these faculties, from the first principles of the science to the farthest extent of its applications, as mathematics."

The considerations set forth at some length in the foregoing extracts, and if time permitted I could cite many other eminent authorities to the same effect, can leave no doubt that the study of mathematics has its part in the development of even those powers which those who are ignorant of the subject suppose are not exercised in this study.

Similarly, it is frequently asserted by men who are not con-

versant with the subject that mathematics has no share in the developing of character, that it offers no opportunity for training the moral faculties. Yet if reverence of truth, if honesty of effort, if patience and self-denial, if perseverance in overcoming obstacles, if clear thinking, if any or all of these have any effect in forming character, then the study of mathematics may rightfully claim at least a modest share in building of character. I do not care to go as far as Berthelot who claims that there are moral faculties that can be put in full play only by instruction in mathematics; on the other hand, it cannot be denied that bad mental habits tend toward bad moral habits and that mathematics has a large part in correcting bad mental habits. Vice is largely due to error, confusion, and false reasoning, while mathematical training makes for truth, clearness of thought, and correct reasoning. Says W. H. Metzler in an article in the *Journal of Pedagogy,* "The fact that a piece of mathematical work must be either right or wrong and if wrong the mistake must be discovered and corrected by the student, and that a false step in a mathematical demonstration must lead to a false result, and that correct reasoning must lead to a correct result, is so close an analogy to moral life that the student gets an excellent training in habits of honesty and moral uprightness." Like views are expressed by many other eminent teachers and thinkers. Reidt, than whom there is no greater authority on mathematical pedagogy, says, "Exercise in the most rigorous thinking that is possible will of its own accord strengthen the sense of truth and right, for each advance in the ability to distinguish between correct and false thoughts, each habit making for rigor in thought development will increase in the sound pupil the ability and the wish to ascertain what is right in life and to defend it." C. P. Echols, in his report on the mathematics at West Point, remarks in a like strain, "A general course in mathematics should be required of all officers for its practical value, but no less for its educational value in training the mind to logical forms of thought, in developing the sense of absolute truthfulness, together with a confidence in the accomplishment of definite results by definite means." Dutton in his *Social Phases of Education in the School and the Home* discusses this same tendency of the study of mathematics. "Mathematics," he says, "does furnish the power for deliberate thought, and accurate statement, and to speak the truth . . . Gossip, flattery, slander, deceit, all spring from a slovenly mind that has not been trained in the power of truthful statement, which is one of the highest utilities."

Time fails me to dwell any longer on this point or on the contributions which the study of mathematics makes to the development of the esthetic faculties of the individual. Let me merely suggest in passing that inasmuch as harmony, order and simplicity are the source of all beauty, aesthetic satisfactions of a high order may be found in the delicate and marvelous harmony, order and simplicity of form and number relations which the study of mathematics discloses as well as in color and tone combinations of the so-called fine arts.

Let us then pass on to those powers of the mind which have been generally, if not universally, recognized as finding their fullest and most effective development in the pursuit of mathematical studies. These are:

1.   The power of undivided attention and prolonged concentration.

2.   The power of exact definition, of clear statement, and of critical analysis.

3.   The power of deductive reasoning, of drawing logical conclusions from given premises.

That mathematics is the most efficient agency for acquiring the power of quick attention and prolonged concentration of mind has never been seriously questioned by competent critics. Sir William Hamilton, the ablest of all those who depreciate the value of mathematical education, was compelled to admit that there remained one virtue in the pursuit of mathematics that could not be argued away. This virtue, to use his own words, "is the curing the vice of mental distraction and cultivating the habit of continuous attention." So also Lord Bacon, who had little knowledge and even less appreciation of mathematics, nevertheless held, "If one is easily distracted and unable to keep his attention as long as he should, mathematics provides a cure." The reason for this must be perfectly obvious to any teacher. Without undivided attention the student can not master even the simplest demonstration in geometry, without prolonged concentration of mind he will be hopelessly lost in the more complicated proofs. As Whately pointed out, there are probably as many steps of pure reasoning in one of the longer propositions of geometry as in a whole volume of argumentation on some other subject. All these steps must be held in mind and connected in their sequence before the proposition can be said to have been mastered.

The close relation which the power of prolonged and concentrated attention bears to efficiency in life's work is familiar to all. Say Ex-President Eliot, "The great thinkers and doers, philosophers and inventors, soldiers and rulers, are alike in possessing this power of concentrated attention; and in common men and women this is the most valuable of all mental faculties. To rouse, awake, inculcate, and train this power in the child and the youth should be a principal object in education for efficiency."

Again the study of mathematics furnishes the best possible training in the exact definition of terms, and in the clear analysis of a subject under consideration. In mathematics, as nowhere else, the teacher may insist on exact definitions and the unequivocal use of terms for the simple reason that the terms used in mathematics admit of such definition and use. In most other subjects the terms used do not admit of exact definition and often depend for their meaning on the caprice of the speaker or writer. Take such terms as honor and beauty and love and virtue—these terms change their meaning with the race, nationality, education, age, and even sex of the person using them. But mathematical terms, such as triangle, circle, binomial, function, locus, have but one signification. This signification must be understood before the term can be used at all. In mathematics, therefore, the student can be brought to recognize the absolute necessity of mastering the meaning of words preliminary to their use as a vehicle of thought. Half of the misunderstanding and futile controversies in active life arise from the ambiguity in the use of words.

Of equal importance with the habit of the exact use of terms is the power to analyze a problem, to recognize what is essential and what is unessential in the consideration of a problem, to distinguish between the relevant and the irrelevant. That mathematics in all its branches calls for the constant exercise of this power must be apparent to all. In every proposition in geometry what is essential to the proof must be discerned and singled out, what is unessential must be ignored. The figure employed in the demonstration must be so chosen as to reveal the essential relations of points and lines, all other points and lines are suppressed or ignored. So in every problem in arithmetic or algebra the student must perceive and single out what is relevant to the solution of the problem from what is irrelevant; little if any progress can be made toward the solution until this has been done. The constant exercise of this power of analyzing a prob-

lem, of separating essentials from non-essentials, of avoiding all superfluous words and empty phrases, of presenting the truth in its naked form without figures of speech or flights of rhetoric, using only such words as are clear and such arguments as are certain—it is the constant exercise of these powers that produce the mathematical mind, a trait of mind which characterizes mathematicians and their works. It is largely for reasons such as the foregoing that mathematics has come to be accepted as a synonym for exactness, clearness, and certainty.

I now come to consider the effect of the study of mathematics on that power of the mind which without question stands highest in the hierarchy of mental powers, the reasoning power. It is in this power that we find the sharpest line of demarcation between man and the lower animals. So it is this power that most clearly differentiates man from man. There is in respect to this power a greater difference between a Newton and the average man of the street than there is between this man and such animals as a horse or a dog. Now it is exactly this power, which of all the powers of man is of the greatest service to man, that admits of unlimited development, and for the development of which mathematics has proved itself the most efficient instrument. All men, no doubt, possess this power in a rudimentary instinctive form, but to reason correctly is primarily an art which, like any other art, can only be acquired by careful, systematic training. It is as necessary to learn to reason before one can reason consecutively and logically as it is to learn to read or to write, to swim or to skate. Says Locke in his *Conduct of the Understanding,* "Would you have a man reason well, you must use him to it betimes; exercise his mind in observing the connection between ideas, and following them in train. Nothing does this better than mathematics, which, therefore, I think should be taught to all who have the time and opportunity, not so much to make them mathematicians, as to make them reasonable creatures," and in another place, "I have mentioned mathematics as a way to settle in the mind a habit of reasoning closely and in train; not that I think it necessary that all men should be deep mathematicians, but that, having got the way of reasoning which that study necessarily brings the mind to, they might be able to transfer it to other parts of knowledge, as they shall have occasion. For in all sorts of reasoning, every single argument should be managed as a mathematical demonstration; the connection and dependence of ideas should be followed till the mind is brought

to the source on which it bottoms, and observes the coherence all along." Similarly, Berkely remarks, "It hath been an old remark, that geometry is an excellent logic. And it must be owned that when the definitions are clear, when the postulates can not be refused, nor the axioms denied; when from the distinct contemplation and comparison of figures, their properties are derived by a perpetual, well-connected chain of consequences, the objects being still kept in view, and the attention ever fixed upon them; there is acquired a habit of reasoning, close and exact and methodical; which habit strengthens and sharpens the mind, and being transferred to other subjects is of general use in the inquiry after truth."

This high office of mathematics in supplying the most efficient instrument for acquiring the art of reasoning his never been successfully challenged. Says John Stuart Mill, "Up to this time, I may venture to say that no one ever knew what deduction is, as a means of investigating the laws of nature, who had not learned it from mathematics, nor can anyone hope to understand it thoroughly, who has not, at some time in his life, known enough of mathematics to be familiar with the instrument at work."

I will conclude my argument on this point by quoting a page from one of Fitch's *Lectures on Teaching*. These are his words: "Suppose then, I want to give myself a little training in the art of reasoning; suppose I want to get out of the region of conjecture and probability, free myself from the difficult task of weighing evidence, and putting instances together to arrive at general propositions, and simply desire to know how to deal with my general propositions when I get them, and how to deduce right inferences from them; it is clear that I shall obtain this sort of discipline best in those departments of thought in which the first principles are unquestionably true. For in all our thinking, if we come to erroneous conclusions, we come to them either by accepting false premises to start with—in which case our reasoning, however good, will not save us from error, or by reasoning badly, in which case the data we start from may be perfectly sound, and yet our conclusions may be false. But in the mathematical or pure sciences—geometry, arithmetic, algebra, trigonometry, the calculus of variations or of curves—we know at least that there is not, and can not be, error in our first principles, and we may therefore fasten our whole attention upon the process. As mere exercises in logic, therefore, these

sciences, based as they all are on primary truths, relating to space and number, have always been supposed to furnish the most exact discipline. When Plato wrote over the portal of his school, "Let no one ignorant of geometry enter here," he did not mean that questions relating to lines and surfaces would be discussed by his disciples. On the contrary, the topics to which he directed their attention were some of the deepest problems—social, political, moral—on which the mind could exercise itself. Plato and his followers tried to think out together conclusions respecting the being, the duty, and the destiny of man, and the relation in which he stood to the gods and to the unseen world. What had geometry to do with these things? Simply this: That a man whose mind had not undergone a rigorous training in systematic thinking, and in the art of drawing legitimate inferences from premises, was unfitted to enter on the discussion of these high topics; and that the sort of logical discipline which he needed was most likely to be obtained from geometry—the only mathematical science which in Plato's time had been formulated and reduced to a system. And we in this country (England) have long acted on the same principle. Our future lawyers, clergy, and statesmen are expected at the university to learn a good deal about curves, and angles, and numbers and proportions; not because these subjects have the smallest relation to the needs of our lives, but because in the very act of learning them they are likely to acquire that habit of steadfast and accurate thinking, which is indispensable to success in all the pursuits of life."

But whether or not mathematics has the large share in the training of those powers on which efficiency in life depends, there still remains the other consideration, which is that the subject matter itself of which mathematics treats, that the knowledge which it conveys, is itself of the highest utility. The relations, principles, processes and methods which the study of mathematics reveals are vital to a comprehension of natural phenomena and indispensable to a solution of the world's major problems. Space and number relations are in the very nature of things the most fundamental of all relations. There is no activity in life which does not demand a thorough knowledge of form and measure, of order and magnitude. It is through knowledge of relations of magnitude and form that we are able to distinguish between order and chaos, it is mathematics that enables us to determine exact relations of whatever kind. Every law of nature in so far as it is exact is mathematical in its nature. Says Young in

his *Teaching of Mathematics*, "Little can be understood of even the simplest phenomena of nature without some knowledge of mathematics, and the attempt to penetrate deeper into the mysteries of nature compels simultaneous development of the mathematical processes." Says an anonymous writer in the *Edinburgh Review* as touching the science of astronomy, "The long series of connected truths which compose the science of astronomy have been evolved from the appearances and observations by calculation, and a process of reasoning entirely geometrical. . . . It is by geometry that we are enabled to reason our way up through the apparent motions to the real orbits of the planets, and to assign their positions, magnitudes and eccentricities. And it is by application of geometry . . . to the general laws of mechanics, that we demonstrate the law of gravitation, trace it through its remotest effects on the different planets, and, comparing these effects with what we observe, determine the densities and weights of the minutest bodies belonging to the system. The whole science of astronomy is in fact a tissue of geometrical reasoning, applied to the data of observation; and it is from this circumstance that it derives its peculiar character of precision and certainty." And again, "With an ordinary acquaintance of trigonometry, and the simplest elements of algebra, one may take up any well-written treatise on plane astronomy, and work his way through it, from beginning to end, with perfect ease; and he will acquire, in the course of his progress, from the mere examples put before him, an infinitely more correct and precise idea of astronomical methods and theories, than he could obtain in a lifetime from the most eloquent general descriptions that ever were written."

If time permitted I could cite similar testimony, from the most eminent scientists in their respective fields, that what is true of astronomy is equally true of all the various branches of physics, and in an increasing measure of chemistry, psychology, meteorology, physiology, and in a lesser degree of the newer sciences of political economy and sociology. The fact is that the field which mathematical modes of thought, mathematical methods and processes dominate is expanding day by day, and must inevitably continue to expand, for all inquiry, of whatever kind, all science, has for its final aim quantitative relations in the determination of which mathematical methods and processes are the only efficient instruments.

In conclusion I will cite two or three illustrations, chosen from

my own experience, to show how a little knowledge of mathematics makes for efficiency even in average walks of life. During the past few years I have had submitted to me for an opinion several different methods which their authors believed solve the famous trisection problem, also two different methods for squaring the circle. I can only conjecture how much time the originators of these methods spent in their attempts, but I am sure that it must have been considerable. A little knowledge of the real character of these problems would have saved these persons from this useless labor, and inevitable disappointment and chagrin.

On another occasion a citizen of Seattle submitted to me a manuscript which he intended for publication, and which he claimed contained a wonderful discovery that he had made during years of experience in the city treasurer's office. It dealt in great detail with a rule for computing the successive payments of improvement assessments, together with the accrued interest. I immediately recognized it as the well-known rule for summing a geometric progression, which any student of algebra should have been able to give him. Another gentleman called at my house and with a very secretive air told me that he had discovered a short-cut for certain computations in surveying, which he intended to copyright in the hope of becoming rich as well as famous. Of course he was disappointed and seemed rather offended when I explained to him that his discovery was a familiar relation in elementary trigonometry. Not long ago, a university professor, one of my colleagues, spent considerable time and effort in constructing a series of curves to prove that teachers of certain classes do not grade their students scientifically. He assumed as an axiom that probability curves dealing with living or biological phenomena must of necessity be symmetrical. Sufficient knowledge of mathematics would have acquainted him with the fact that many probability curves are asymmetrical, so that there was absolutely no point to his argument, and of course no merit whatever in his well-meant labor. Such cases as these are very common and come under the observation of every mathematician.

ANOMALOUS FORMS IN WRITING NUMBERS.

By Florian Cajori.

There is a curious modification of the Hindu-Arabic notation which was in vogue among the Spanish and Portuguese about the beginning of the nineteenth century and for about three centuries previously, which is worthy of note in the history of the Hindu-Arabic numerals. Both the Spanish and Portuguese possessed symbols for "thousands," which were placed between the third and fourth figures of numbers. The Spanish symbol differed from the Portuguese; it was called *calderon* and looked in manuscripts like a U, sometimes more like a V, with a horizontal line drawn across it. These symbols were widespread in Spain and especially in the Spanish-American colonies.

A contract drawn in Mexico City in 1649 for the working of a silver mine may be cited as an illustration. The certification endorsed upon the contract gives the symbols "7 U 291 e 4 t° 6 gs.," which are seen from the contract itself to stand for "7291 pesos, 4 tomines, 6 granos." The U here closely resembles an O. A document relating to the sale of real estate in Mexico City in 1718 contains "4 U 255 p," signifying "4255 pesos." Many other cases could be cited. In 1802 a *printed* symbol ") was used in Mexico City for "thousands," resembling the Greek symbol ")′ for 900, but having no known historical connection with it.[1] It has been pointed out by Professor D. E. Smith that the use of the letter U, in place of the Roman M, to designate 1,000, occurs in a Spanish arithmetic of 1549 and in several other Spanish writers.[2] In these publications the U occurred independently of the Hindu-Arabic notation and not as a mixture with it.

The Portuguese designated "thousands" by a symbol called *cifrās* which closely resembled our modern $. My attention has been directed to this matter by an article in the *Independent*.[3] From that article it appears that this Portuguese symbol was used in precisely the same manner as was the Spanish U or V. It was used in Portugal as early as 1544. Thus, in "300$506" it was used to separate the thousands from the hundreds; in "745$" it was used to signify 745$000. This is more fully explained in the Portuguese *Grand Dictionary* of Vieira, Porto, 1873, and in other Portuguese dictionaries.

[1] For more detailed information see my article, "On the Spanish Symbol U for 'thousands,' " in the *Bibliotheca Mathematica*, 3rd S., Vol. 12, 1912, pp. 133, 134.
[2] D. E. Smith, *Rara Arithmetica*, Boston, 1908, p. 240
[3] *The Independent*, Vol. 78, June 1, 1914, pages 412, 413.

That it should have been found necessary to supplement the Hindu-Arabic notation by the interpolation of a special symbol to signify "thousands" is a matter of marked interest. In most countries the use of "commas" to divide numbers into periods of three has been regarded as sufficient for the purpose of identifying the units.

That the Portuguese symbol $ should be advanced as the forerunner of the modern dollar mark is natural. But anyone who has attempted to trace with certainty the origin of symbols knows how hopeless it is to reach results worthy of serious attention, except by the critical study of manuscripts. The simple fact that some old symbol resembles the modern dollar mark is not sufficient. An unbroken line of descent must be established. Thus far, no more evidence is adduced to show the descent of our dollar mark from the Portuguese *cifras* than has been adduced to prove its descent from U and S ("Uncle Sam"), or from H S, or from IIS, or from the stamp of the mint of Potosi in Bolivia, or from the "Pillars of Hercules," as seen in the "pillar dollar," or from the "piece of eight" |8|, or from the union of R and 8. Fifteenth century Italian manuscripts on arithmetic contain symbols closely resembling our modern dollar mark; they signify not "thousands," but "pounds." In the absence of any connecting links, the derivation of our dollar mark from these Italian symbols could not be seriously considered. The history of the dollar mark has been a matter of painstaking research. The present writer has worked in many libraries and examined many manuscripts written in widely different parts of the American continent, for the special purpose of tracing the origin of the dollar mark. These studies[4] yielded as conclusive evidence as a purely inductive study can furnish, that the dollar mark is an evolution from p^s, the abbreviation for "pesos."

[4] See my articles in the *Popular Science Monthly*, December, 1912, pages 521-530, and in *Science*, N. S., Vol. 38, 1913, pages 848-850.

A PARADOX IN CONGRUENT TRIANGLES.

By R. M. MATTHEWS,
Riverside, California.

No amount of mathematical study will teach a person to reason correctly with machinelike precision; on the other hand, conscientious study can teach us to be *adequately critical* of any argument. The following paradox illustrates the need to be adequately critical. A method for proving the congruence of two right triangles seems applicable to triangles in general, but when so used it proves too much.

To prove two right triangles congruent when a leg and hypotenuse of one are equal to those parts of the other, place the triangles with hypotenuses in coincidence, the equal legs lying opposite each other from the same vertex (Figure 1). The vertices of the right angles are joined, forming an isosceles triangle with the legs given equal. The equality of the base angles here implies the equality of their complements and so the equality of the other two legs. Accordingly, the right triangles are congruent. It seems that this method might hold good for proving two triangles congruent when two sides and the angle opposite one side in the first triangle are equal to corresponding parts in the
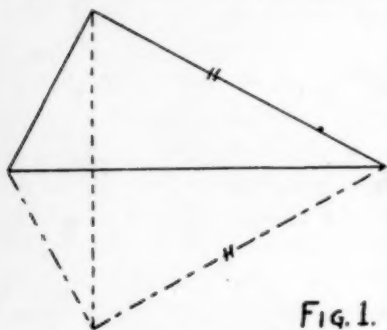
FIG. 1.
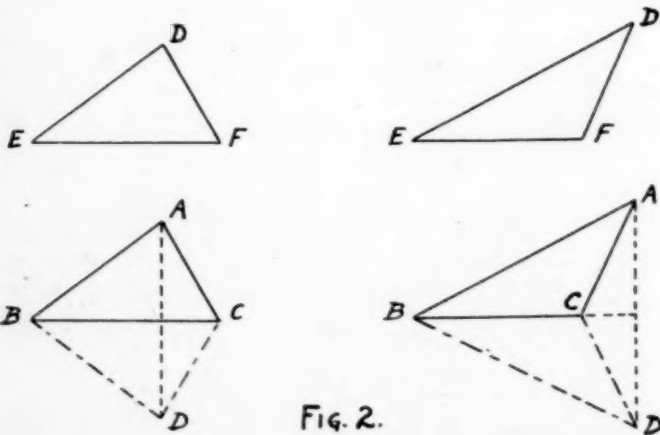
FIG. 2.

other. In triangles ABC and DEF (Figure 2), let AB = DE, BC = EF, ∠A = ∠D. Place the triangle with BC and EF in coincidence, with A lying directly opposite D. Draw AD: Now

$$\angle\,BAD = \angle\,BDA,$$

and whether AD cuts BC or BC extended, it follows that

$$\angle\,CAD = \angle\,CDA.$$

Therefore AC = CD, and the triangles are congruent.

There must be a flaw in this semingly sound proof, for there exist triangles which fill the conditions stated yet are not con-
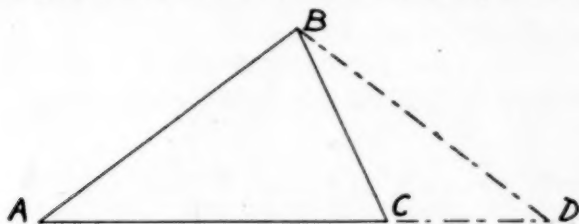
Fig. 3.

gruent. When two such triangles are constructed and placed as directed (Figure 3), we observe that our formal logic has failed to note that it is possible for

$$\angle\,CAD = \angle\,CDA = 0,$$

in which case it is invalid to infer AC = CD.

ELECTROLYSIS MITIGATION.

A paper giving a brief general statement regarding electrolysis and corrosion and presenting a detailed discussion of the various methods of electrolysis mitigation that have been proposed or tried for protecting underground structures has just been issued by the Bureau of Standards, Department of Commerce. Methods of mitigation are treated under two heads, namely, those applicable to pipes and those applicable to the railway return system. The conclusion is drawn that while certain of the methods applicable to pipes, particularly pipe drainage and insulating joints, are often valuable, they should in general be used as auxiliary measures only, the chief reliance being placed on reducing potential drops in the railway return to reasonably low values. Where return feeders are necessary for accomplishing this, insulated feeders are preferable because more economical.

In the last chapter there is presented a discussion of the principles on which regulations concerning electrolysis mitigation should be based, and the responsibilities of owners of underground utilities as well as of the railway companies are emphasized.

Copies of this publication, *Technologic Paper, No. 52,* may be obtained without charge from the Bureau of Standards, Washington, D. C.

THE HYDROGEN-MAGNESIUM RATIO LABORATORY EXERCISES.

By Robert W. Curtis,

College of the City of New York, New York.

In a former number of this journal,[1] there was presented a form of experiment in which the determination of the ratio of the hydrogen evolved to the magnesium dissolved in the reaction with dilute sulphuric acid was made the object of a laboratory exercise. Use was made of the principle of displacement of the Victor Meyer apparatus.

The purpose of the present communication is to show one or two improvements, together with an indication of results obtained therewith.
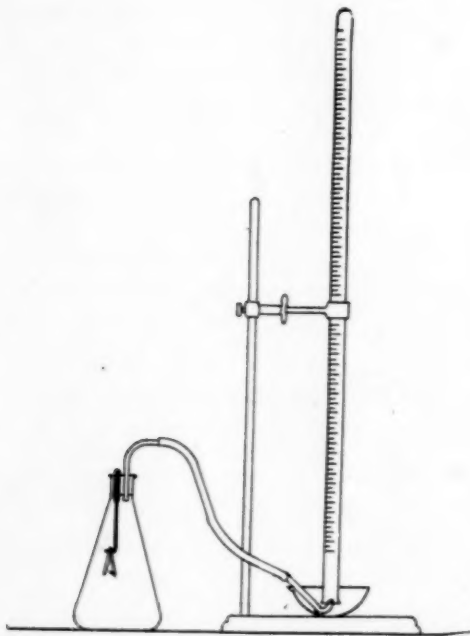
A form of the experiment appeared in a recently published manual,[2] in which the hydrogen is evolved in a large test-tube, and collected in a Hempel gas burette. Contact between magnesium and acid was brought about by the turn of a glass rod inserted through the stopper, on which the folded magnesium ribbon was hung. It was seen that the application of this ingen-

[1]School Science and Mathematics, Vol. 13, p. 37 (1913).
[2]Mattill: *Laboratory Directions for Elementary Chemistry*, Holt, 1914, p. 98.

ious device, as a part of the apparatus formerly described in these pages, would obviate the nuisance of the small homeopathic vial, and eliminate the error due to the heat of dilution of the acid. The modification was immediately tried out with classes numbering about two hundred students.
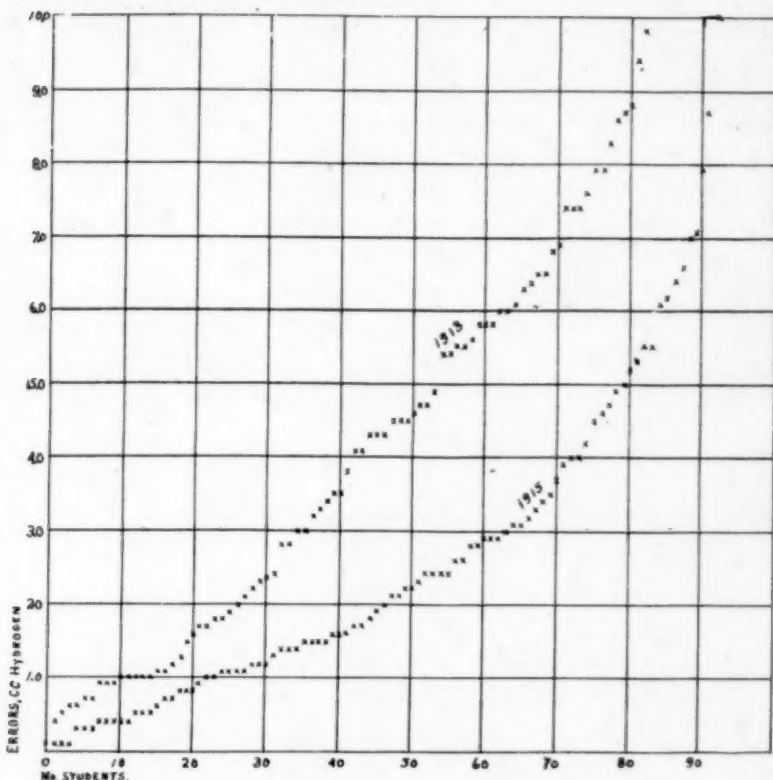
Diagram 1 shows the arrangement of apparatus. At the proper time the folded magnesium ribbon is allowed to slide off the hook by inclining the flask (taking hold of the flask at the edge of the mouth to avoid expanding the air in the flask by the heat of the hand).

In subsequent exercises also, the superficial oxide was removed from the magnesium ribbon used, by fastening one end of a long strip in a vise and drawing it between fine emery cloth and then removing the dust by drawing between cloth.

Diagram 2, though not a curve in the mathematical sense, shows, graphically, results obtained with the new form of apparatus compared with same obtained with the form first described.

The errors are here plotted in order of magnitude without regard to algebraic sign.

Inspection shows that in the 1913 exercises about sixty per cent of the students obtained results with errors less than 6 cc. of gas, while the plot for 1915, with the modified apparatus, shows nearly seventy per cent obtained their results with errors less than 3 cc. It would appear that an error of $\pm$ 3 cc. under the conditions of the exercise is fair allowance as a criterion for acceptance of a student's results.

The average volume of hydrogen at $0°$, 760 mm. from 1 cm. of ribbon was 4.18 cc. in the 1915 experiments. This value, multiplied by the length of ribbon used by the student and the factor for correction to room temperature and barometric pressure for a gas collected over water, for the day on which the class performs the experiment, may be taken as the value from which the student's error, is to be calculated.

The average volume per cm. ribbon should be determined each year from the students' results in order to get an idea of the working of the exercise, and bring to attention any unusual condition, such as lack of uniformity in the magnesium ribbon, for example. This is conveniently accomplished by plotting the values in order of magnitude and taking the average from inspection of the approximate curve so formed.

The author would be pleased to send a mimeographed copy of directions for this experiment, such as is put in the students' hands, to anyone sending a stamped addressed envelope.

PRODUCTION OF COKE.

During the year 1914 there was produced in the United States 34,555,914 short tons of coke, valued at $88,334,217, according to the annual statement on the manufacture of coke now available for distribution by the Geological Survey.

TYPHOID FEVER CONTROLLED.

Three years ago the field men of the Geological Survey, as well as some of the office force, took advantage of the offer of the War Department to supply official antityphoid serum, and practically the entire force of men was inoculated. Since that time, as far as reported, there has been no serious case of typhoid fever among those inoculated. Two cases of typhoid among the topographic engineers indicate the great effectiveness of this inoculation. In both these cases the men simply felt "off feed" for a couple or three days and refused to go on the sick list; in fact typhoid would not have been suspected in either case except that in one of them somebody suggested the possibility, and an exhaustive hospital examination, blood test, etc., showed that the engineer had a theoretically well-developed case of typhoid, the practical results of which, however, failed to incapacitate him for duty, so that he did not even go to bed for one day.

WESTON A. C. AND D. C. PORTABLE ELECTRODYNOMO-
METER AMMETER, MODEL 370.

Problems hitherto considered impossible of solution have been solved in the designing of these instruments. They are the latest development of instruments of this type and embody characteristics never before attained.

They are ammeters of precision adapted to use on A. C. or D. C. circuits. They are guaranteed to an accuracy of one-fourth of one per cent full scale value on either *D. C.* or *A. C.* circuits of any frequency to 133 cycles per second and any wave form. They can be used on circuits of any commercial frequency as high as 500 cycles per second without error. Double ranges are furnished in this model.

Their movable systems have an extremely low moment of inertia and are very effectively damped. Indications are independent of room temperature, the heating effect of current passing through the coils, and the instruments are shielded from external magnetic fields.

The scales are $5\frac{1}{4}$ inches long. Owing to the principle of operation, these instruments cannot be made with scales uniform throughout their entire length but the upper four-fifths portion of the scale is remarkably equalized. Each scale is hand-calibrated and is provided with a mirror over which the knife-edge pointer travels and the pointers are equipped with a simple zero-setting device.

For complete information regarding Model 370, write for Bulletin No. 2003. Other models in this group are Model 341 A. C. and D. C. Portable Ammeter described in Bulletin 2004; Model 310 Single Phase Portable Wattmeter and Model 329 Polyphase D. C. Portable Wattmeter described in Bulletin 2002.

CAMBRIDGE BOTANICAL SUPPLY COMPANY.

There are undoubtedly many science instructors who have the erroneous idea that the Cambridge Botanical Supply Company of Waverley, Mass., deals simply with apparatus and supplies of a botanical nature. This idea should be corrected, as this firm does a general business, covering all lines of scientific work, especially in the sciences of chemistry, botany, physiology, metrology, and physics. A glance at their catalogue will indicate that users of apparatus can secure from this house almost any kind of material which they may need. This is one of the oldest houses of the kind in existence, and its unfailing reliability and integrity are a complete guarantee that anyone ordering from it will secure entire satisfaction.

INTERESTING IDIOSYNCRASIES OR INEXCUSABLE IGNO-RANCE.

As part of a college education in science, there should be instruction given to prospective science teachers, concerning the ordering of science equipment and supplies. No apparatus house would dare to come out boldly and state that eighty per cent of the science teachers ordering supplies, do not know how to order what they want, but that statement is pretty near the truth.

In discussing the matter with an experienced man, he stated, "Doubtless many of our teachers in the small high schools of the country do not know how to order." We are prepared to go further and state that, frequently, teachers in the largest high schools in the largest cities do not know how to specify what they wish. It is true that the recognized science equipment companies in the United States publish catalogs in which the specifications are so carefully and accurately given, that the customers, if they follow the catalogs, need have no ambiguous items in their lists.

The following are a few of the items taken at random from a current order file:

1. 10 t. t's.
2. 20' Rubber Tubing.
3. 12 Rubber Corks.
4. 1 Assorted Spider.
5. 5 Magnets.
6. 1 Galvanometer.
7. 1 Spool Wire.
8. 2 Lenses.
9. 1 Tuning Fork.
10. 1 Burner.

1. Under this item the shipping clerk must decide whether he will ship T-tubes, thistle tubes, or test tubes. If he guesses test tubes, then he must also guess, not only the size which the customer had in mind, but he must decide by intuition whether culture tubes, chemical test tubes or ignition tubes are desired.

2. How can the office determine whether the customer desires red, white, or black tubing; whether the tubing is to be thin, medium or heavy wall; and, what is very important, how is he to guess the size of the tubing desired?

3. The writer has never seen a "rubber cork" though he has seen the name hundreds of times upon the estimates. He is familiar with rubber and cork stoppers. How is the office to determine whether the customer desires a cork or a rubber stopper unless he guesses from the word "rubber" which was used in the list? He probably would guess correctly, but how is he to know what size of stopper is desired or whether the customer is expecting to receive a solid, 1-hole or 2-hole stopper?

4. Biological catalogs offer assortments of such insects as beetles, wasps and spiders. When a customer orders "I Assorted Spider," does he expect the dealer to supply the body of one species, the head of another, the spinnerets of a third and the legs of a fourth species?

5. Under this number, the intuition of the office must determine whether the customer requires a permanent magnet or an electromagnet. If a permanent magnet; then he must decide whether the customer is thinking about a horseshoe or a bar magnet, and when the office has supplied this to its doubtful satisfaction, it must then decide upon the size.

6. "1 Galvanometer." This frequently occurs upon high school lists. Since "Galvanometers," according to grade, are sold all the way from $1.00 to $100, the office must do some shrewd guessing if it fills the order for this item without correspondence, which means delay.

7. "One Spool Wire." How is the office to determine whether the customer desires aluminum, brass, copper, zinc, iron, German silver or fuse wire? Of course it is easy to eliminate magnesium, platinum and gold wire, without running much risk of disappointing the customer. But how is he to predetermine the size of the wire desired, to say nothing of whether it is to be bare, single cotton, or D. C. C., or if it is to be single or double silk covered?

8. "Lenses." Are these convex, concave or concavo-convex? As soon as the office has guessed that it is probably a double convex lens that is desired, it is then confronted with this problem: Is the customer thinking about a smooth edge or a finished edge? What did he have in mind as to the focus of the lenses and what diameter does he want? Are the two lenses to be alike?

9. "One Tuning Fork." What *letter* does he desire? What price is he willing to pay?

10. "One Burner." Did this customer desire an alcohol lamp? If so, is it to be glass, brass or copper, and what capacity? Or did he desire a Bunsen burner? If a Bunsen burner, does he want one that will cost him 20c or $1.00? Does he wish a single, double, triple or quadruple tube? If it is not a Bunsen burner, possibly it may be a gasoline or kerosene blast lamp, or any one of fifty different styles of "burners" on the market, each one for a special purpose.

The above ten items are fairly representative of thousands that can be taken from the order files of nearly every apparatus

house and they briefly present some of the problems which the apparatus office must solve in order that it may ship the goods promptly, and deliver to the customer exactly what he wants at the time he wants it, without vexatious delays which are disagreeable to the customers.

Again, science masters in large high schools and colleges are as frequently at fault as those in smaller institutions. Note the following illustrations taken from correspondence:

A superintendent writes:

"Gentlemen:

"Under separate cover, by express, I am sending you microscope I wrote you about some few days ago. I do not know if it was never any good or if it has gotten out of line or what. I think that you had better send cost of repairs to me, then I will let you know what to do to it."

One customer orders, "One Oxyhydrogen Voltmeter," without any further specifications.

The head of the department of physics in a well-known college writes:

"I am highly pleased with the static machine which you shipped. It has been some time since I used one of these instruments. Will you please tell me whether I am to use calcium chlorid or sulfuric acid in the *Leyden jars?*"

To answer these questions without offending the customer is a secret art in the apparatus office.

A master of physics in one of the largest high schools in the East, and the author of a widely used textbook on physics, orders: "1 Aneroid Barometer,——," giving the catalog number and price. The company shipped the instrument. Many months later, the customer wrote:

"The instrument ordered under requisition No. —, under date of ——, has recently been examined by me, and found unsatisfactory. I have subjected it to all degrees of moisture, even put it into live steam, and the hand has never moved. What do you propose to do in order to make it satisfactory, since the bill has been paid?"

The company looked up the entire correspondence, found that the man through the purchasing department of the city actually ordered the aneroid barometer which was shipped, and so wrote the physics man and gently hinted that it was doubtless a hygrometer which he had in mind, rather than a barometer.

This letter, in due course, brought to the office a stinging and sarcastic letter flatly stating that he knew the difference between a barometer and a hygrometer. The company then quoted from the order a second time, giving all the data. The customer refused to believe it.

The next move of the company was to remove from the files the entire list of correspondence from beginning to end, originals and copies, and send these proofs to the physics master. A long silence reigned. Eventually, the correspondence was returned to the files without any further comment.

The writer does not desire to criticise the profession at large, but by means of these few concrete examples, to point out to the teachers preparing lists, the absolute necessity of giving catalog numbers, the names which belong to the numbers, and the size or other specifications, when such sizes and specifications are essential to the correct interpretation of the customer's desire. Nothing has been said about the lack of judgment or sense of proportion because there is a chance to object. But when a school has only $100 in the year to spend and orders over $50 worth of platinum, it is time that some one in charge of the funds had something to say about the wisdom of the different items purchased.

BEAVER DAMS LAST 150 YEARS.

How long will a beaver dam last? At least 150 years is the conclusion of the New York Conservation Commission, as the result of an examination of trees growing upon a very old dam in the vicinity of Eighth Lake in the Fulton Chain.

Scrub white cedars on this dam were cut down, in order to count their annual growth rings, by W. C. Talmage, of Camp Waubun, Seventh Lake, whose study of beavers during the last thirty years has taken him over many of the wild portions of the United States and Canada. A section of one, just received by the Commission, is nine inches in diameter and shows 125 annual rings. Others as large as sixteen inches have rotted in the center until they are mere shells, whose age can only be guessed at.

On the supposition that the trees could not have taken root upon the dam until it had become covered with humus from dead leaves, or silt washed on by the stream, it is believed by the Commission that the dam dates back certainly until 1765, before the power of the Iroquois Confederacy was broken, and when the Adirondacks were still in their beaver hunting country of apparently inexhaustible supply. Then every stream held evidence of their skill, and the pelts that they supplied even passed for currency at Fort Orange and New York.

In their old haunts along the Fulton Chain they are coming into their own again, until they have become one of the prime attractions of the region.—*American Forestry.*

PROBLEM DEPARTMENT.

By J. O. Hassler,

Englewood High School, Chicago.

Readers of this magazine are invited to propose problems and send solutions of problems in which they are interested. Problems and solutions will be credited to their authors. Address all communications to J. O. Hassler, 2301 W. 110th Place, Chicago.

Algebra.

451. *Proposed by N. P. Pandya, Sojitra, Dt. Petlad, India.*

Find three numbers, or different sets of three numbers each, such that their sum is a perfect cube, and the sum of their squares is a perfect fourth power.

Solution by Norman Anning, Chilliwack, B. C.

(Letters denote integers only.)

From the identity
$$(x^2+y^2+z^2)^2 = (x^2-y^2-z^2)^2+(2xy)^2+(2xz)^2,$$
established and discussed by contributors to the *American Mathematical Monthly*, we see that if a number can be expressed as the sum of three squares, so also can its second power. Put

$x = a^2-b^2-c^2,$
$y = 2ab,$
$z = 2ac,$

and we have a perfect fourth power equal to the sum of three squares:
$$(a^2+b^2+c^2)^4 = p^2+q^2+r^2, \tag{1}$$
where

$p = a^4+b^4+c^4+2b^2c^2-6c^2a^2-6a^2b^2,$
$q = 4ab(a^2-b^2-c^2),$
$r = 4ac(a^2-b^2-c^2).$

By giving a, b, and c different sets of values we can make a table of sets of numbers satisfying one of the requirements.

The problem is solved if, in such a table, we find a set for which
$p+q+r = $ a perfect cube.

Example: $41+68+16 = 5^3,$ $41^2+68^2+16^2 = 9^4.$

Those who dislike "trial and error" may find solutions ad libitum by proceeding as follows:

Multiply both sides of equation (1) by
$(p+q+r)^{12n+4}$ $(n = 0, 1, 2, \cdots).$
Then
$$[(a^2+b^2+c^2)(p+q+r)^{3n+1}]^4 = x^2+y^2+z^2,$$
where

$x = p(p+q+r)^{6n+2},$
$y = q(p+q+r)^{6n+2},$
$z = r(p+q+r)^{6n+2},$
$x+y+z = [(p+q+r)^{2n+1}]^3 = $ a perfect cube.

The set, x, y, z, satisfies both the given conditions.

Example: When $a = b = c = 1$, equation (1) gives
$3^4 = 7^2+4^2+4^2,$ $7+4+4 = 15.$

Since 15 is not a perfect cube, multiply by 15^4,
$45^4 = 1575^2+900^2+900^2,$ $1575+900+900 = 15^3.$

Quod erat inveniendum.

An interesting by-product:
$12+24+41 = 9+32+36,$ $12^2+24^2+41^2 = 9^2+32^2+36^2.$

452. *Proposed by Harold B. Clapp, Williamantic, Connecticut.*

Solve
$$\frac{2w}{e^w} = \frac{v+m}{v-m},$$

where e is the base of the Naperian logarithms and m is a constant.

I. *Solution by Norman Anning, Chilliwack, B. C.*

$$\frac{2m}{e^v} = \frac{v+m}{v-m}$$

$$\frac{\frac{2m}{e^v}-1}{\frac{2m}{e^v}+1} = \frac{m}{v},$$

$$\frac{e^{\frac{m}{v}}-e^{\frac{-m}{v}}}{e^{\frac{m}{v}}+e^{\frac{-m}{v}}} = \frac{m}{v},$$

$$\tanh \frac{m}{v} = \frac{m}{v},$$

$$\frac{m}{v} = 0,$$

$$\therefore \qquad v = \infty.$$

II. *Solution by Nelson L. Roray, Metuchen, N. J.*

$$\frac{2m}{e^v} = \frac{v+m}{v-m},$$

$$\frac{2m}{v} = \log \frac{v+m}{v-m} = \log \frac{1+\frac{m}{v}}{1-\frac{m}{v}},$$

$$= 2 \cdot \frac{m}{v} + \frac{2}{3} \cdot \frac{m^3}{v^3} + \frac{2}{5} \cdot \frac{m^5}{v^5} + \cdots$$

$$0 = \frac{2m^3}{v^3} \left[\frac{1}{3} + \frac{m^2}{5v^2} + \frac{m^4}{7v^4} + \cdots \right].$$

$$\therefore \qquad v = \infty.$$

By using the exponential series and expanding $\frac{v+m}{v-m}$ as a series, we get the same result.

453. *Proposed by Katherine S. Arnold, Milwaukee, Wisconsin.*

If lines be drawn from a fixed point to all the points of the circumference of a given circle, the locus of all their points of bisection is a circle. Two cases—the point may be within or without the circle.

I. *Solution by F. M. Phillips, Central College, Pella, Iowa.*

Let A be the given point, and C the center of the given circle, both cases. Draw AB, any line from the point A, intersecting the circumference of the circle C in B. Take P′ its middle point.

To prove the locus of P′ is a circle:

Draw the line AC and take P its middle point. Draw BC and PP′. PP′ is parallel to BC and equal to ½ of it. Then P′ is always at the distance ½BC from P. That is, the locus of P′ is a circle with P as a center, and a radius ½BC.

II. *Solution by Walter C. Eells, U. S. Naval Academy, Annapolis, Md.*

Let the given fixed point be b distant from the center of the given circle of radius a. Take rectangular axes through the center of the given circle, such that the X-axis passes through the given point. Then if $x'y'$ are the coordinates of a point on the circle,

$$x'^2 + y'^2 = a^2.$$

Also $(b, 0)$ are the coordinates of the fixed point. Designating by (x, y) the coordinates of the middle point of the line joining (x', y') to $(b, 0)$,

$$x = \frac{x'+b}{2}, \qquad\qquad y = \frac{y'-0}{2},$$

whence

$$x'^2 = 4x^2-4bx+b^2, \qquad y' = 4y^2.$$

Therefore, we obtain by substitution,

$$\left(x-\frac{b}{2} \right)^2+y^2 = \frac{a^2}{4}.$$

This is the equation of a circle satisfying the given conditions, with center at $(\tfrac{1}{2}b, 0)$ and radius $\tfrac{1}{2}a$.

Evidently there are three cases, according as the point is without, on, or within the circle, i. e., according as $b >, =, < a$. We may also subdivide into six cases, namely:

$b > 3a$: Circles do not intersect.

$b = 3a$: Circles tangent externally.

$3a > b > a$: Circles intersect in two points.

$b = a$: Circles tangent internally.

$b < a$: Circles do not intersect.

$b = 0$: Circles concentric.

III. *Solution by L. E. A. Ling, La Grange, Ill.*

Case I. The point within the circle.

Let P be any point within the circle. Draw any two chords AB and CD through P. Let F, E, H, G be the midpoints of AP, PB, PD, PC.

Then

$$\text{AP} \times \text{PB} = \text{PC} \times \text{PD}.$$

Dividing by 4,

$$\frac{\text{AP}}{2} \times \frac{\text{PB}}{2} = \frac{\text{PC}}{2} \times \frac{\text{PD}}{2}.$$

or

$$\text{PF} \times \text{PE} = \text{PG} \times \text{PH}.$$

Then will F, E, G, H be concyclic, and the circle through F, E, G, H will be the locus required.

[If two lines intersect in a point so that the product of the segments of the one line is equal to the product of the segments of the other, the ends of the lines are concyclic.]

Case II. When the point is without the circle.

Let P be any point without the circle. Draw secants PAB, PCD, and let F, E, H, G be the midpoints of the segments PA, PB, PD, PC. The proof follows in a manner exactly analogous to Case I.

IV. *Solution by Nelson L. Roray, Metuchen, N. J.*

Let R be the given point within the circle; LRT, the chord through R that is the diameter of the given circle; P, the midpoint of RT; K, the midpoint of RL; L_1RT_1, any other chord through R; P_1, the midpoint of RT_1.

$PP_1 \parallel TT_1$ and $P_1K \parallel T_1L$.

$\therefore \angle PP_1K$ is a right angle, hence locus of P_1 is a circle whose diameter is PK.

Let R be the given point without the circle. Using the same notation as above, we get in the same way $\angle PP_1K$ is a right angle and hence locus of P_1 is a circle whose diameter is PK.

If R is on the circumference, it is easily proved that locus of P_1 is a circle whose diameter is the radius of the given circle. Q. E. D.

454. *Proposed by Yeh Chi Sun; Peking, China.*

Given the three altitudes of a triangle, construct the triangle.

I. *Solution by the proposer.*

Let p, q, r be the lengths of the three altitudes. Draw $MB = \dfrac{qr}{p}$
and on it construct a triangle MBC, making $BC = q$ and $MC = r$.
Draw MD $\perp$ to BC and equal to r. Through D draw a line $\parallel$ to BC inter-
secting MB (or prolonged) at F, MC (or prolonged) at E. The tri-
angle MEF is the required triangle.

Proof: In $\triangle$ MBC,

$$MB : BC : MC = \frac{qr}{p} : q : r$$
$$= qr : qp : rp$$
$$= \frac{qr}{pqr} : \frac{qp}{pqr} : \frac{rp}{pqr}$$
$$= \frac{1}{p} : \frac{1}{q} : \frac{1}{r} \,.$$

But $\triangle MEF \sim \triangle MBC$. $\therefore$ In $\triangle MEF$, the ratios of three sides are also
$1/p : 1/r : 1/q$. But altitude $MD = r$. $\therefore$ MEF is the required triangle
because altitudes of a triangle are inversely proportional to its sides.

$$Q.\ E.\ D.$$

II. *Solution by Mabel G. Burdick, Stapleton, N. Y.*

Let p, q, r be the given altitudes. Construct any three lines a', b', c'
such that $p : q = b' : a'$ and $p : r = c' : a'$. Construct a triangle with
sides a', b', c'; construct a similar triangle with corresponding sides a,
b, c, and having the altitude on a equal to the given line p. Let the alti-
tude on b equal y. Then $p : q = b' : a' = b : a$ by construction. Two
altitudes of a triangle are to each other inversely as the sides upon which
they are drawn. $\therefore$ $p : y = b : a$ and $y = q$. In a similar manner we
prove the altitude on c equal to r, and abc is the required triangle.

III. *Solution by H. O. Jay, Chicago, Ill.*

Let p, q and r be the given altitudes. Construct a triangle with sides
p, q and r. Call the altitudes upon these sides a, b and c, respectively.
Now construct a second triangle with sides a, b and c. Call the altitudes
upon these sides p', q' and r' respectively. Since the altitudes are inversely
proportional to the sides upon which they are drawn, respectively,

$$p : q : r = \frac{1}{a} : \frac{1}{b} : \frac{1}{c} = p' : q' : r'.$$

Hence construct a triangle similar to triangle number 2 and with alti-
tudes p, q and r, a well-known construction.

Trigonometry.

455. *Proposed by H. E. Trefethen, Waterville, Maine.*

Given
$$\tan \alpha = \cos \epsilon \tan \lambda, \quad \text{and} \quad \epsilon = 23° 27'.$$
Find λ for maximum and minimum values of $\lambda - \alpha$.

Solution by Nelson L. Roray, Metuchen, N. J.
$$\tan \alpha - \cos \epsilon \tan \lambda = 0,$$
$$\frac{\sin \alpha}{\cos \alpha} - \cos \epsilon \frac{\sin \lambda}{\cos \lambda} = 0,$$
$$\sin \alpha \cos \lambda - \cos \epsilon [\sin (\lambda - \alpha) + \cos \lambda \sin \alpha] = 0,$$
$$\sin \alpha \cos \lambda (1 - \cos \epsilon) - \cos \epsilon \sin (\lambda - \alpha) = 0,$$

or $\quad \sin(\lambda-a) = \sin a \cos \lambda \dfrac{(1-\cos \epsilon)}{\cos \epsilon}$,

$$= \tfrac{1}{2}[\sin(\lambda+a)-\sin(\lambda-a)]\dfrac{1-\cos \epsilon}{\cos \epsilon}.$$

or $\quad \sin(\lambda-a) = \sin(\lambda+a)\dfrac{1-\cos \epsilon}{1+\cos \epsilon}$.

Evidently $\lambda-a$ is a maximum if $\sin(\lambda+a)$ is a maximum, $\qquad$ (A)
That is, if $\sin(\lambda+a) = 1$.

$$\therefore \quad \lambda-a = \sin^{-1}\left(\dfrac{1-\cos \epsilon}{1+\cos \epsilon}\right) , \text{ a maximum,}$$

or $a = \lambda-\sin^{-1}\left(\dfrac{1-\cos \epsilon}{1+\cos \epsilon}\right)$.

$$\tan a = \dfrac{\tan \lambda- \dfrac{1-\cos \epsilon}{2\sqrt{\cos \epsilon}}}{1+\tan \lambda \dfrac{1-\cos \epsilon}{2\sqrt{\cos \epsilon}}}.$$

Substituting in the given equation this value of $\tan a$, we have
$(\sqrt{\cos \epsilon})^2 \tan^2\lambda-2\sqrt{\cos \epsilon}\,\tan\lambda+1 = 0$,

$$\text{or } \tan \lambda = \dfrac{1}{\sqrt{\cos \epsilon}}.$$

$$\lambda = \tan^{-1}\left(\dfrac{1}{\sqrt{\cos \epsilon}}\right),$$

$$= 16° \ 14' \quad (\textit{Principal value only}).$$

For minimum value of $\lambda-a$, we have from (A)
$$\sin(\lambda-a) = 0 \text{ or } \lambda = a.$$
Hence $\tan\lambda (1-\cos \epsilon) = 0$,
$$\text{or } \lambda = 0.$$

PROBLEMS FOR SOLUTION.

Algebra.

466. *Proposed by F. M. Phillips, Pella, Iowa.*
Solve for integral values of x, y and z.

$$x+y^2+z^2 = 2, \qquad\qquad (1)$$
$$x^2-y^2+z^2 = 4, \qquad\qquad (2)$$
$$x^2-5xy^2+z^2 = 8. \qquad\qquad (3)$$

467. *Proposed by F. L. Sanders, Connersville, Ind.*
The area of a triangle whose sides are 3, 4 and 5 is 6, and if the sides are 13, 14 and 15, the area is 84. Will some one find the next set, or a general solution for such sets, of three consecutive integers which as the measures of the sides of a triangle give rise to an integral area?

Geometry.

468. *Proposed by F. M. Phillips, Pella, Iowa.*
Find the locus of the centers of all circles, (a) tangent to a given line and a given circle, (b) tangent to two given circles.

469. *Proposed by Clifford N. Mills, Brookings, S. D.*
In a triangle $A_1B_1C_1$, a circle is inscribed, touching the sides in $A_2B_2C_2$. A circle is inscribed in the triangle $A_2B_2C_2$, touching the sides of $A_2B_2C_2$ in $A_3B_3C_3$. This process is continued an infinite number of times. Show

that $\quad A_\infty = B_\infty = C_\infty = \dfrac{\pi}{3}$.

Fallacy.

470. *Proposed by the Editor.*

One of the eleven solutions printed in this department this month is not correct. Find it and point out the error.

CREDIT FOR SOLUTIONS.

446. S. R. Wenkata Ramaaiyer. (1)

447. Edward Fleischer, Yeh Chi-Sun, S. R. Wenkata Ramaaiyer. (3)

448. Three incomplete solutions. (3)

449. Edward Fleischer, Yeh Chi-Sun, S. R. Wenkata Ramaaiyer. (3)

450. One incorrect solution. (1)

451. Norman Anning, one incorrect solution. (2)

452. Norman Anning, Nelson L. Roray. (2)

453. Katherine S. Arnold, A. Bogard, Mabel G. Burdick, Walter C. Eells, F. C. Gegenheimer (2), M. Helen Kelley, L. E. A. Ling, F. M. Phillips, Florence Pinney, Nelson L. Roray, Elmer Schuyler, three incorrect solutions. (15)

454. Roy C. Andrews, A. Bogard, Mabel G. Burdick, Mary E. Caster, H. C. Carver, Shungo Furni, C. N. Mills, Morris Neifeld, Florence Pinney, Elmer Schuyler, Yeh Chi-Sun, three incorrect solutions. (14)

455. Norman Anning, Nelson L. Roray. (2)

Total number of solutions, 46.

RIVER OLDER THAN THE MOUNTAINS IT DRAINS.

The guidebooks to western travel issued by the United States Geological Survey explain some things which at first sight seem inexplicable. How much more interesting it is to see something of which you know enough to understand and appreciate its wonders. Ogden Canyon, a deep cleft through the towering Wasatch Mountains, overlooking the Great Salt Lake, is one of the show places along the Oregon Short Line, yet many of the thousands of people who have viewed its beauties would have enjoyed them more had they first read the little statement of geologic history given in the Geological Survey's guidebook of the Overland Route.

Ogden Canyon, a deep notch with bare cliffs of hard pink quartzite on both sides, was cut in the solid rock by the river which flows through it. Running water, carrying sand and gravel, acts as a saw or file, and, given time enough, can cut through the hardest rocks. Ogden River was flowing west along its present course before the lofty Wasatch Mountains came into existence. The raising of the mountains went on slowly for ages, so slowly that the river kept its place by cutting down its ever-rising bed, carving a deep and narrow canyon straight through the block of the earth's crust as it rose. In no other way can we rationally account for a river rising on one side of the range and flowing directly across it. Movement of the mountain mass has continued down to the present time—at least, there has been recent disturbance along the base of the Wasatch Range, as is shown by faults which traverse the lake deposits and the modern alluvial aprons. Some of the breaks are so new as to be devoid of vegetation. The upward movement of the mountains has been so continuous that the river has had no opportunity to widen its valley, a task which it will begin as soon as the mountains cease rising.—*Overland Guidebook, U. S. Geological Survey.*

SCIENCE QUESTIONS.

By Franklin T. Jones

University School, Cleveland, Ohio.

Readers of School Science and Mathematics *are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Questions and Problems for Solution.

213. *Proposed by E. V. Hjort, Mason City, Iowa.*

One of the farmer girls in the high school states that in her section of the county it is a general impression among the farmers that a tile drain drains the land better than an open ditch.

Is this so, and if it is so, why is it?

214. *Proposed by Ross Grange, Sioux City, Iowa.*

The chemistry examination following was given to cover the first semester's work in high school chemistry given in Sioux City High School. I should suggest that it be printed in *Science Questions* of School Science and Mathematics.

If possible, I should like to have it discussed—(a) as to whether or not it covers the ground sufficiently; (b) is it too long for a two-hour examination; (c) is it too difficult; and (d) does it give enough importance to applied topics?

Please answer questions numbered 215, 216 and 217.

Chemistry Examination, Sioux City High School,
First Semester, 1915-1916.

Time limit, two hours. Write only on one side of the paper. Use pencil for diagrams. Write all answers in sentences. Write on each of the first eleven questions.

I. (5) Neatness and spelling.

II. (5) 1. How many inches in 1 m.? 2. How many cm. in 1 m.? 3. How many mg. in 1 g.? 4. How many mm. in 1 dm.? 5. How many mm. in 1 cm.? 6. How many cc. in 1 l.? 7. How many g. in 1 l. water at 4 degrees C.? 8. How many g. in 1 kg.? 9. How many cg. in 1 g.? 10. 1 l. is approximately equal to what common English unit of volume?

III. (5) What changes in each case accompany the heating of (1) tin, (2) mercury, (3) copper, (4) magnesium, in air? Give equations for any two, designating for which they are.

215. IV. (10) Oxygen was collected in a bottle over water, but the inverted bottle was not filled completely by the gas. The inside level was 32.5 mm. above the outside level; the temperature of water was 22 degrees C.; the barometer in the laboratory read 726 mm., and the gas measured, under these conditions, 840 cc. What volume would this oxygen occupy when at standard conditions, levels adjusted and perfectly dry? (Express the result correct to the first decimal place.)

V. (10) Describe the action of sodium on water under the following headings: (1) Description of apparatus; (2) method of collecting gas; (3) precautions; (4) diagram; (5) what other metals would act on water in a similar way?

VI. (5) State in your own words the Atomic Hypothesis.

VII. (10) Describe fully your laboratory preparation of HCl gas under the following heads: (1) Substances used; (2) equation; (3) method of collection; (4) diagram; (5) five physical properties.

216. VIII. (5) 290 cc. of nitrous oxide gas weighs 0.574 g. when measured at standard conditions. Calculate its molecular weight. (Show all of your calculations).

IX. (5) State (1) Avogadro's hypothesis; (2) Law of Definite Proportions. Define (1) atomic weight; (2) deliquescent substance.

X. (10) *Boys.* Give a diagram, equation and brief discussion of Castner's process of obtaining sodium hydroxide. *Girls.* (5) (*a*) How would you test cloth chemically to determine whether it was woolen or cotton? (5 (*b*) Why does table salt cake? How could this be prevented?

XI. (5) Write symbol equations for each of the following actions (must be correct to receive credit): (1) Sodium hydroxide with sulphuric acid; (2) Sulphuric acid with zinc; (3) Silver nitrate with potassium chloride; (4) electrolysis of water; (5) manganese dioxide with hydrochloric acid. Choose any *five* of the remaining.

XII. (5) Write about 200 words on the sources, extraction and purification of salt.

XIII. (5) *Boys.* Make a diagram of a fire extinguisher such as is used in the building.

XIV. (5) *Girls.* Why is soda used in cleaning? How is hydrolysis illustrated in this?

XV. (5) How would you test a solution to prove whether or not it contained chloride?

XVI. (5) How would you use the flame test to determine whether a substance was a sodium or potassium salt?

XVIII. (5) What is meant by the statement that the molecular weight of NaCl is 58.5? Define G. M. W. What relation exists between the vapor density of a gas and its molecular weight? A G. M. W. of any gas occupies what volume at S. T. P.?

XVIII. (5) Give formulas for: (1) Nitric acid; (2) ammonia gas; (3) ammonium hydroxide; (4) baking soda; (5) calcium carbonate. Give names of (1) Na_2CO_3, (2) MgO, (3) $NaClO_3$, (4) NH_4HCO_3, (5) Ag_2S.

217. XIX. (5) If you were a manufacturing chemist and had quantities of chlorine formed, to what kinds of firms would you try to sell it?

XX. (5) What is the molecular weight of $(NH_4)_2SO_4$? Why is hydrogen gas written as H_2 instead of H? How many replaceable hydrogen atoms in a molecule of acetic acid $HC_2H_3O_2$?

XXI. (5) Give two examples from your everyday experiences of (1) combustion, (2) slow oxidation, and (3) spontaneous combustion.

XXII. (5) If your gas stove burners at home give a yellow flame, how could it be remedied? Why would your method correct it? Where is the hottest part of a non-luminous flame

Note concerning Question 193.

In answer to the first answer given to question 193, the element of time certainly is involved, as it is the rate of change of number of lines of force which determines the E. M. F. of the secondary. A. D. C. would make a strong magnetic field, but would induce a current only while it was building up to full strength. If the secondary E. M. F. is proportional to several factors, can anyone give me complete formula for A. C. Transformers? —Niel Beardsley, Bloomington, Ill.

Solutions and Answers.

200. *From an entrance examination of Harvard College.*

A 50-gallon tank, containing air at atmospheric pressure (15 pounds per square inch) is connected by a pipe to the city water mains, the pressure in which is 60 pounds per square inch. Assuming that the air remains at constant temperature, how many gallons of water will flow into the tank?

Answer by A. H. Smith, Riverside, Cal.

60 : 15 :: *x* : 1.
x = 4, increase in pressure.
¼ x 50 = 12½ gal., vol. of air.
50 — 12½ = 37½ gal., vol. of water.

201. A moving stairway moves at the rate of 2 feet per second. The maximum number of people who can ride on the stairway at any one time is 120. The length of the stairway is 50 feet, and its vertical rise is 30 feet.

(*a*) Neglecting friction and assuming that the average weight of one person is 150 pounds, what is the maximum power required to operate the stairway?

(*b*) If the efficiency of the system is 60 per cent, what is the maximum power required?

Solution by A. H. Smith.

(a) $120 \times 150 \times 30 = 540000$ ft. lbs. of work done.
  $50 \div 2 = 25$ sec., time to reach top of stairs.
  $(540000 \div 25) \div 550 = 39.27$ H. P., *Answer (a)*.

(b) $39.27 = 60\%$.
  $100\% = (39.27 \div 60)\ 100 = 65.45$ H. P., *Answer (b)*.

204. *Proposed by E. E. Wolfe, Pittsburgh, Pa.*

A block floats with one-half submerged in water. How much of its volume will be under water when a liquid (immmiscible with water) of specific gravity .25 is poured on so as to cover the entire block?

[NOTE. In the letter Mr. Wolfe wrote the Editor, he stated that there was some discussion as to the correct answer. Four solutions were received, all of which are submitted. Please do not attribute the incorrect solution to any individual.]

Solutions were submitted by J. P. Drake, Kansas State Normal School, Emporia, Kan.; F. A. Hanawalt, Middletown, Ohio; Florence Pinney, Sturgeon Bay, Wis.; A. H. Smith, Riverside, Cal.

Solution No. 1.

Assume block is a cube 1 cm. on each dimension.
Let $x =$ distance block sinks in H_2O.
$1-x =$ distance block sinks in other liquid.
Since the area of base of block is 1 sq. cm., the amounts are the volumes of the displaced liquids.
$\therefore (x)1 + (1-x).25 = .5$.
  $x + .25 - .25x = .5$.
    $.75x = .25$.
      $x = .33$ cm. under water.
$(.33 \div 1)\ 100 = 33\%$ under water.

Solution No. 2.

If the block floats one-half submerged in water, its specific gravity $= .5$. Let the two liquids, water and given light liquid, be placed in a vessel and the given block dropped in. Since specific gravity of block is twice that of light liquid, it will lose half its weight when submerged in that liquid (Archimedes' principle). Upon reaching surface of water, the block, being entirely submerged in light liquid above, will sink until it displaces a mass of water equal to its weight in the liquid. Being only half as heavy as in air, it will sink only half as far into the water as it does when submerged in air, i. e., one-fourth of its volume will be under water.

Solution No. 3.

The density of the substance is evidently .5.
Let $x =$ the part out of water when covered with the second liquid, and $1-x$, the part under water when covered with the second liquid.
Then, by the Archimedes principle (taking 1 cc. as the vol.), x times $.25 + (1-x)1 = .5$, therefore, $x = \frac{2}{3}$ the part out of water, *answer*.

Solution No. 4.

$1/2$ of a block $=$ amount of a floating block submerged.
$.25 =$ specific gravity of a liquid immiscible with water.
Required the part of the block under water when the light liquid is poured on to cover the block $=$ what?
$.5 =$ specific gravity of block.
$1 =$ altitude of the block.
$x =$ amount of block covered by water.
$y =$ amount of block covered by lighter liquid.
$x + y = 1$.
The block must displace liquid equal its own mass, so
$x + .25y = .5$.

$x + y = 1.$
$.75y = .5.$
$y = 2/3$ part covered by lighter liquid.
$\therefore 1/3 = $ part of block under water.

205. *Proposed by W. L. Baughman, East St. Louis, Ill.*

A light wire is stretched over two smooth pulleys at a distance of 10 feet from each other in the same horizontal line, and has 112 pounds hung at each end. What weight hung at the middle of the wire will cause it to sag one inch?

Solved by J. P. Drake, Emporia, Kan., and Florence Pinney, Sturgeon Bay, Wis.

Note by F. A. Hanawalt.

I do not think that problem 205 can be worked (solved accurately) unless the diameters of the pulleys are given, for the points of contact of the wire vary as the wire lowers.

Solution by Florence Pinney.
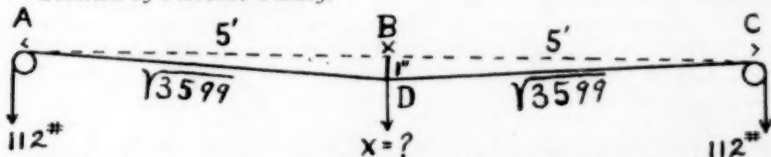
Required force, x, has two components acting in directions DC and DA respectively. Each of these components must equal 112 lbs., for each balances one of the given weights of 112 lbs. In $\triangle$ BDC, BC $= 5$ feet, BD $= 1$ inch, DC is found to be $\sqrt{3599}$ inches. By the law of parallelogram of forces, $x = $ diagonal of a parallelogram, whose sides, DC and DA, are each 112, and included angle $= \angle$ADC,

or $x : 2BD$ (entire diagonal) $:: 112 : \sqrt{3599}$.

$x : 2 = 112 : \sqrt{3599}$.

Solving equation, we find $x = 3.7+$ pounds.

SILICA.

The marketed production of silica in 1914 for use in the manufacture of pottery, paints, scouring soaps, as a wood filler, and as a polisher is reported to the United States Geological Survey to have been 181,731 short tons, valued at $612,829. The annual statement of the Survey on the production of silica (quartz) for 1914 is now available for distribution.

The United States Geological Survey now has available for distribution its annual statement on the clay-working industries in 1914. The total value of all clay products marketed in the year was $164,986,983.

WHAT IS A PLACER?

A placer is an unconsolidated deposit accumulated by mechanical processes, carrying one or more minerals in commercial quantities. All placers are secondary deposits—that is, the material of which they are composed was originally derived by erosion of bed rock. Although it is undoubtedly true that under certain conditions nuggets of placer gold have been enlarged through chemical precipitation, yet this action is a negligible quantity in placers. Placers may be derived solely by rock weathering without water sorting, but more commonly are the result of water transportation, sorting, and deposition. Many of the richest placers are those formed by the erosion of older placers and the reconcentration of their gold.

EASTERN ASSOCIATION OF PHYSICS TEACHERS.

The seventy-second regular meeting of this Association was held at the Billerica shops of the Boston and Maine Railroad on Saturday, December 4th. The party arrived at the shops by a special train from the main line, and were at once taken in charge by Mr. Henry Bartlett, chief engineer of the road, whose guests the Association members were for the day. Mr. C. B. Smith gave the party a few statistics concerning the shops and briefly outlined the course to be taken.

The shops are designed for the repair of locomotives and the general rolling stock of the road, and have been recently constructed. They are thus up to date in every particular. The people in the party spent a most profitable forenoon under the guidance of men connected with the shops, in visiting the various departments and watching the operation of the various machines which are installed to accomplish the work of general car repairing in the most economical manner. The information and experience gained by this forenoon's visit is of an inestimable value.

The afternoon session was quite formal, and on the recommendation of the Executive Committee a number of new members were elected. Mr. R. C. Lowell, Chairman of the Committee on New Apparatus, presented a report. The Committee on Current Events, Mr. R. C. Chittenden, Chairman, made a most interesting and valuable report of the more prominent events which have occurred in the world's history since the last meeting of the Association. The Committee on Magazine Literature had a splendid report to make. Mr. John R. Lunt of the Boys' English High School, Boston, followed this report by an interesting address on Elementary Science as given in his school. This address was listened to with interest, as it brought to the members' minds many new things in the administration of elementary science. Mr. Frederick E. Sears delivered the Vice-President's address on the subject of "Two Needs of Today in Preparatory Science." This, too, was a valuable paper.

Preceding the Saturday's meeting, a smoker of the Association was held at the City Club, Boston, on which occasion the address was given by Professor Edwin H. Hall on "College Recognition of Applied Science." This address was followed by Dr. C. Riborg Mann of the University of Chicago, who talked in his usual interesting way. Following this Professor John F. Woodhull of the Teachers College, Columbia University, addressed the meeting. Several members took part in the discussion.

OREGON STATE SCIENCE AND MATHEMATICS TEACHERS' ASSOCIATION.

A year ago at the annual meeting of the Oregon State Teachers at Eugene, a Science and Mathematics Section was organized and it elected the following as its first officers:

Chairman—Professor E. E. DeCou, University of Oregon, Eugene.

Secretary-Treasurer—Professor L. P. Gilmore, State Normal School, Monmouth.

Executive Committee—Superintendent Karl W. Onthank, Tillamook, Principal F. E. Moore, Ashland, and Mr. Omar Bittner, Portland.

SCHOOL SCIENCE AND MATHEMATICS was chosen as the official organ and all members were urged to secure it for themselves or their schools.

The following excellent program was given at the recent meeting of the State Association at Medford, December 27, 28 and 29, 1915:

"Teaching of Biology; Why? and How? in Oregon?"—Professor A. R. Sweetser, University of Oregon.

"The Present Trend in Geometry Teaching"—Mr. C. Harlow Pratt, Medford High School.

Discussion—Superintendent Daniel Hull, Grants Pass.

"A Vocational Course in Agriculture"—Professor F. L. Griffin, Oregon Agricultural College.

Discussion—Mr. O. I. Gregg, Klamath County High School.

"Recent Progress in the Teaching of General Science"—Mr. G. M. Ruch, Ashland High School.

Discussion—Professor Yakel, Pacific University.

"The Teaching of Social Biology"—Superintendent Karl W. Onthank, Tillamook.

The following officers were chosen for the next annual meeting in Portland:

Chairman—Professor L. P. Gilmore, State Normal School, Monmouth.

Secretary-Treasurer—Superintendent Karl W. Onthank, Tillamook.

Executive Committee—Professor W. P. Boynton, University of Oregon, Principal F. E. Moore, Ashland, and Principal E. L. Keezel, Monmouth.

Marked interest was shown in the strong papers presented at the Association and the rapid growth of the section is assured.   E. E. DeCou.

THE MATHEMATICAL ASSOCIATION OF AMERICA.

On December 30 and 31, 1915, there was held at Columbus, Ohio, the the organization meeting of a new national mathematical association, the call for which had been signed by 450 persons, representing every state in the Union, the District of Columbia, and Canada. The object of the new association is to assist in promoting the interests of mathematics in America, especially in the collegiate field. It is not intended to be a rival of any existing organization, but rather to supplement the secondary associations on the one hand, and the American Mathematical Society on the other; the former being well organized and effective in their field, and the latter having definitely limited itself to the field of scientific research. In the field of collegiate mathematics, however, there has been, up to this time, no organization and no medium of communication among the teachers, except the *American Mathematical Monthly*, which for the past three years has been devoted to this cause. The new organization, which has been named the Mathematical Association of America, has taken over the *Monthly* as its official journal.

President—Professor E. R. Hedrick, University of Missouri.

First Vice-President—Professor E. V. Huntington, Harvard University.

Second Vice-President—Professor G. A. Miller, University of Illinois.

Secretary-Treasurer—Professor W. D. Cairns, Oberlin College.

Publication Committee—Professor H. E. Slaught, University of Chicago, Managing Editor; Professor W. H. Bussey, University of Minnesota, and Professor R. D. Carmichael, University of Illinois.

These officers, together with the following, constitute the Executive Council: Professor R. C. Archibald, Brown University; Professor Florian Cajori, Colorado College; Professor B. F. Finkel, Drury College; Professor D. N. Lehmer, University of California; Professor E. H. Moore, University of Chicago; Professor R. E. Moritz, University of Washington; Professor M. B. Porter, University of Texas; Professor K. D. Swartzel, Ohio State University; Professor J. N. Van der Vries, University of Kansas; Professor Oswald Veblen, Princeton University; Professor J. W. Young, Dartmouth College; Professor Alexander Ziwet, University of Michigan.

NEW YORK STATE SCIENCE TEACHERS' ASSOCIATION.

The seventieth annual meeting of the New York State Teachers' Association was held in Rochester, N. Y., November 22nd, 23rd and 24th. The Science Section, in conjunction with the Physics Club of Western New York, met at West High School on the 23rd and the morning of the 24th.

From the opening of the meeting to the close, the attendance was exceptionally good, and, although the lecture rooms were large, in several instances standing room only was at a premium. The large attendance and enthusiasm at the meeting are indicative of two things: first, that an unusually good program, broad of scope and full of attractiveness, had been arranged; and second, that the speakers more than met the expectations of those who attended the sessions. The papers were fine.

Much credit is due President Billings and his associates of West High who perfected the arrangements for the meeting.

PROGRAM.

Tuesday, November 23rd.

9:30 a. m.—"The Photographic Lens" (illustrated)—Edward E. Ford, Head of Physics Department, West High School, Rochester.

10:30 a. m.—"Some Interesting Phases of Bird Study" (illustrated)—Professor Arthur A. Allen, Ph. D., Cornell University.

12:30 p. m.—Lunch at West High School lunch room.

1:30 p. m.—"General Science"—Harry A. Carpenter, Head of Department of Chemistry, West High School, and Supervisor of General Science, Washington Junior High School, Rochester.

2:30 p. m.—"How to See a Map" (illustrated)—Professor George H. Chadwick, University of Rochester and Ward's Natural Science Museum.

3:30 p. m.—"The Content Method and Results of High School Course in Chemistry"—Professor Alexander Smith, Ph. D., Administrative Head, Department of Chemistry, Columbia University.

4:30 p. m.—Organization.

Wednesday, November 24th.

9:30 a. m.—"Forestry as an Economic Problem for New York" (illustrated)—Dean Hugh Baker, State College of Forestry, Syracuse University.

10:30 p. m.—Adjournment.

In addition to the lectures and papers presented by the various speakers, two very helpful exhibits were arranged through the courtesy of the Western Electrical Instrument Company and Bausch & Lomb.

The exhibit of the Western people was arranged in the chemistry lecture room. It covered the following points:

1. A demonstration of the fundamentals of electrical measurements by means of lantern slides. This included work done by instructors and students.

2. A working exhibit in electrotyping as developed by students in high schools.

3. Practical electrical measuring instruments for the laboratory and lecture room.

The exhibit by Bausch & Lomb was arranged in the physics laboratory. It consisted of photographic materials that pertain to school work.

At the business meeting held Tuesday afternoon, Forrest E. Barter of Niagara Falls High School was elected President and F. P. Freeman of North Tonawanda High School was elected Secretary-Treasurer.

HARRIS C. ALLEN,
Secretary.

THE NEW JERSEY TEACHERS' ASSOCIATION.

The nineteenth regular meeting of this Association was held in the Battin High School, Elizabeth, N. J., on Saturday, December 11th. It was one of the most interesting and inspiring meetings that the Association has ever held. There were about 250 teachers and guests attending the morning meeting. The main feature of the morning session was the address by Dr. Henry H. Goddard, Director of the Department of Research at the Vineland Training School, who spoke on the "Value of Heredity." Professor J. C. Packard of the Brookline, Mass., High School, spoke on "Practical Physics." Both of these addresses were listened to with great interest, and everyone felt more than repaid from these two talks alone. The afternoon was devoted to sectional meetings for the five general departments of the Association. The section meetings were well attended and gave an inspiration to every teacher who was able to be in attendance.

IOWA ASSOCIATION OF MATHEMATICS TEACHERS.

The Iowa Association of Mathematics Teachers met at Des Moines, November 5, 1915, in connection with the meeting of the State Teachers' Association.

The meeting was called to order by President W. E. Beck. The minutes of the previous meeting, and the report of the Secretary-Treasurer for 1912-13-14-15, were read and approved. The President appointed as a Nominating Committee, I. E. Neff, Drake University; E. E. Watson, Parsons College; Miss Martha Meachem, Sac City.

The report on "Elimination of Unnecessary Material from the High School Course in Mathematics" was read by the Chairman, F. K. Williamson, Ottumwa High School. The report gave the result of a questionnaire submitted to the mathematics teachers in a large number of high schools in the state. There was shown a decided tendency toward emphasis on essentials and cutting out nonessentials. This report was distributed to members in mimeographed form. The committee was continued for another year's work on the subject. The other members are: E. E. Watson, Parsons College; Martha A. Beeson, West Des Moines High School; R. D. Daugherty, Iowa State Teachers College; E. S. Sells, Sanborn, Iowa; A. F. Caldwell, Ames, Iowa; Nancy G. Carroll, Davenport High School; Fannie A. Quaife, Marshalltown High School; Mr. Brueckner, Iowa City.

The report of the Committee on Publicity was accepted and a like committee, with the Vice-President of the Association as Chairman, was requested for the coming year.

Dr. S. A. Courtis, Head of the Department of Educational Research, in the Detroit schools, addressed the Association on "Efficiency in Mathematics Teaching with Special Reference to Standard Tests in Algebra and Geometry." This address was followed by questions and general discussion.

The Nominating Committee reported as follows:

President—Maud St. John, East Des Moines High School.

Vice-President—F. K. Williamson, Ottumwa High School.

Secretary-Treasurer—Ira S. Condit, Iowa State Teachers College.

The report was accepted and the Secretary instructed to cast the ballot of the Association for the officers as reported.

At the close of the session, Dr. Courtis gave some standard research tests in geometry to a large group of teachers, for the purpose of accumulating data concerning adult tests.

ARTICLES IN CURRENT PERIODICALS.

American Mathematical Monthly for January; *5548 Kenwood Ave., Chicago, Ill.; $2.00 per year:* "The Mathematical Association of America," W. D. Cairns, Secretary; "Digital Reckoning of the Ancients," Leon J. Richardson; "A Simple Proof of Hart's Theorem," J. L. Coolidge; "A Tribute to John Howard Van Amringe," C. J. Keyser.

American Naturalist for January; *Garrison, N. Y.; $4.00 per year, 40 cents a copy:* "The Evolution of the Cell," the late E. A. Minchin; "The Eugster Gynandromorph Bees," T. H. Morgan; "Pink-Eyed White Mice, Carrying the Color Factor," Dr. J. A. Detlefsen; "Parthenogenesis and Sexual Reproduction in Rotifers," Dr. D. D. Whitney.

Condor for January-February; *Los Angeles, Calif.; $1.50 per year, 30 cents a copy:* "Philadelphia to the Coast in Early Days, and the Development of Western Ornithology Prior to 1850," Witmer Stone; "Characteristic Birds of the Dakota Prairies. III. Among the Sloughs and Marshes," Florence Merriam Bailey; "New and Interesting Bird Records from Oregon," Stanley G. Jewett; "A Personal Supplement to the Distributional List of the Birds of California," William L. Dawson.

Educational Administration for January; *Baltimore, Md.; $2.00 per year, 25 cents a copy:* "The Junior College," Alexis F. Lange; "An Extra-Classroom Study of the Decatur High School," J. O. Engleman; "Variability of Judgments in Equating Values in Grading," Alexander Inglis; "A Scholarship Honor System in High School," J. M. Giles.

Geographical Review for January; *New York City; $5.00 per year, 50 cents a copy:* "The Oak Tree and Man's Environment" (twelve illustrations), J. Russell Smith; "Fault Coasts in New Zealand" (five maps, seventeen diagrams), C. A. Cotton; "The Geographical Factor in Agricultural Industries," Carl S. Schofield.

National Geographic Magazine for January; *Washington, D. C.; $2.50 per year, 25 cents a copy:* "How the World is Fed" (eighty-five illustrations, 110 pages), William J. Showalter.

Photo-Era for February; *Boston, Mass.; $1.50 per year, 15 cents a copy:* "Pictorializing," John W. Gillies; "Sepia Tones Up to Date," E. J. Wall; "The Amateur Photographer," Sigismund Blumann; "Printing-In Clouds from Separate Negatives," William S. Davis; "The Effect of Bellows-Extension on Exposure," Philip Conklin; "Speed- and Exposure-Tables for a 3A Kodak," Franklin H. Smith.

Physical Review for January; *Ithaca, N. Y.; $6.00 per year, 60 cents a copy:* "Reflection of Slow Moving Electrons by Copper," Albert W. Hull; "Einstein's Photoelectric Equation and Contact Electromotive Force," R. A. Millikan; "The Absorption Spectra of the Blue Solutions of Sodium and Magnesium in Liquid Ammonia," G. E. Gibson and W. L. Argo; "The Free Ions in the Atmosphere of the Tropics," J. R. Wright and O. F. Smith; "On the Construction of Sensitive Photoelectric Cells," Jacob Kunz and Joel Stebbins; "Reflection from, and Transmission through Rough Surfaces," A. F. Gorton; "The Distance between two Parallel Transparent Plates," C. Barus; "Comparison of the Fall of a Droplet in a Liquid and in a Gas," O. W. Silvey; "The Fall of Mercury Droplets in a Viscous Medium," O. W. Silvey; "A Method for the Measurement of Small Capacities," Will C. Baker; "The Effect of Magnetization on the Opacity of Iron to Rontgen Rays," A. H. Forman; "An Investigation of the Transmission, Reflection and Absorption of Sound by Different Materials," F. R. Watson; "The Radioactive Deposit from the Atmosphere on an Uncharged Wire," S. J. M. Allen.

Popular Astronomy for February; *Northfield, Minn.; $3.50 per year, 35 cents a copy:* "Markings on Aristillus" (Plate I), E. C. Slipher; "The History of the Discovery of Solar Spots—Continued," Walter M. Mitchell; "Report on Mars. No. 14 (Plates II and III), William H. Pickering; "Celestial Motions in the Line of Sight," Russell Sullivan; "The Motions of the Spiral Nebulae," O. H. Truman.

School Review for February; *University of Chicago Press; $1.50 per year, 20 cents a copy:* "Courses in Special Methods of Teaching for High

Schools, with Reference to Mathematics," W. D. Reeve; "A Modern City's High-School System—Los Angeles," Arthur M. Fenwick; "Uses of the Term 'Secondary' in American Education," B. F. Pittenger; "A Junior High School," Herbert S. Weet.

School World for January; *London, England; 7s. 6d. per year:* "Teaching the Calculus in Secondary Schools." R. Wyke Bayliss; "The Cooperation of Schoolmasters and Architects in the Design of School-Buildings," Experientia; "Scientific Discovery. I.—Insect Life," R. A. Gregory; "Training Classes for Temporary War Service"; "Secondary Education in Scotland."

Scientific Monthly for February; *Garrison, N. Y.; $3.00 per year, 30 cents a copy:* "The Avoidable Loss of Life," Dr. J. Howard Beard; "The Causes of War," Professor I. W. Howerth; "The Islands of the Mid-Pacific," Dr. Alfred Goldsborough Mayer; "Battles and Rainfall," Professor Alexander McAdie; "Some Phenomena of Fluid Motion and the Flight of a Baseball," W. S. Franklin; "Hunger and Food," George J. Peirce; "The Reincarnation of James Eights, Antarctic Explorer," Dr. John M. Clarke.

Zeitschrift für den Physikalischen und Chemischen Unterricht for November; *Berlin, verlag von Julius Springer; M. 12:* "Herstellung von Goniometer und Spiegelbussole für Schülerübungen," K. Noack; "Mikrochemische und mikroelektrische Versuche mit Metallwolle für Schülerübungen," G. Gruber; "Demonstrationsluftthermometer und einige thermische Versuche aus Physik und Chemie," W. Roth.

INK FOR WRITING ON GLASS.

An ink which can be used for writing on bottles, etc., in place of paper-labels, and for naming microscopic slides, lantern slides and similar purposes, is made by dissolving two hundred grains of shellac in three ounces of methylated spirit. Solution is complete in a few days, and the liquid is then strained through muslin, and has added to it three-quarters of an ounce of borax which has been dissolved in six ounces of hot water and allowed to cool. The pigment preferred for the ink is mixed with this borax solution, which is added to the shellac solution little by little, the latter being contained in a large bottle and well shaken after each addition.

TEACHERS ARE NOT "WORKERS."

A test case carried up to the Supreme Court of the state of Washington recently decided that the law which had been passed, making all employment agencies unlawful, did not include teachers in its scope for the reason that teachers were not the "workers" which the law was intended to protect. It is time that teachers were recognized as *professional* men and women, rather than classed with laborers and the like. Education is as much of a profession as the law, medicine or the ministry. Its demands, mentally and morally, are as high and as severe. Probably no class of people needs less legal protection and supervision than teachers. They can be depended upon to attend to their own affairs.

In most states, however, that have laws governing employment agencies, the construction of the law is so broad that teachers have been classed with laborers, section hands, etc.! The decision of the Washington court is tardy but valuable recognition and will serve to put teachers in the professional class where they rightfully belong.   B. F. CLARK.

CLASSROOM SAYINGS.

REMARKABLE SPELLING: Nyle, Ucan, Ukon, Whyoming, Princaple part, Pollar regions, Ocean currants, Ciranavadas, Sahhra Nevads, Katskats, Custskilts, Kaskas, Adronducks, Adderondakes.

From answers to questions in geography:
"The Kaskades are in Austria Hungary"; "New York"; "N. Brazil."
"The Peyermides are on the coast of France."
"The Alps are in Oregon and Nevada."
"Alps are in Switzerland and Sweeden."
"Andes are in Africa"; "eastern part of New York"; "southwest of America."
"The Adirondacks are in southern California"; "western part of United States from Washington to New Mexico."
"The Cascades are in South America."
"The Coast Range is along the Atlantic coast."
"The Pyrenees are in northwestern California."
"The Catskills are in southern Canada"; "eastern California."
"Himalayas are east of New York"; "West Indes."

In a zoology examination:
"SPIDERS.—After the adult female has spun her web, the courtship begins. Some nice young man (a spider), wishing to show off his beauty, struts about the web, winking his eye every once in a while. Then the female entices him to her web and then bites his leg. She don't like him. Then along comes another man, the same performance goes on, and he is the apple of the lady's eye. She takes him in and they mate, and again the female lays eggs. After living a few weeks with her man, the female spider, wanting him no more, eats him."—Dorothy H.

"What does the paramœcium feed upon?"
"It eats decayed vegetarians."

In Wisconsin:
Pupil: "Please hand me the motor and knocker" (mortar and pestle).

Mr. McClellan: "Marion, what is gravity?"
Marion: "It's the substance that keeps people on the earth and is the center of their equilibrium."

In answer to the question, "What is true of the sides of a right triangle?" one of my sophomore girls said, "The square of the base plus the square of the latitude is equal to the square of H."
One of the senior girls, in defining work, said, "Work is what you get out of anything when you put time and energy into it."
Another, in defining power, said: "Power is what it takes to move feet."

"A plane figure is something that is plane so you can make it out."

"A reflex angle has parallel sides."

"A geometric point is a dot on a paper with a sharp pencil."

"A right angle is a line with two sides."

"A geometric solid is taste, size, weight and color."

Here is a gem which needs an explanation. The instructor had been trying to get the class to grasp the proper conception of a geometric solid and had resorted to the old expedient of placing a chalk box on the table, calling the pupil's attention to it; then removing it and trying to get the pupil to visualize the outline of the space occupied by the box. It seemed to work very well. Here was what one student produced at examination: "A geometric solid is a solid that is not there!"

VISITING CLASSES IN ONE'S OWN SCHOOL.

Many secondary schools have installed a system of allowing their teachers to visit other schools one or two days during the school year, in order that they may familiarize themselves with the methods of these foreign schools. Apparently, somebody has entirely overlooked the fact that in our larger schools very few of the teachers know anything about the methods and procedure of teachers in their own corridor. All high schools should adopt a scheme by means of which teachers in any particular school could become perfectly familiar with the methods of their colleagues. The weaker teacher cannot help but be strengthened in his work; and the stronger and more experienced teacher will be put on his mettle more actively than he otherwise would be; and the lazy, incompetent teacher will be compelled to either resign from the faculty or else mend his ways to such an extent that he will be characterized as a fairly efficient teacher. This can all be done from the principal's office in such a way as not to lose one class hour on the part of any teacher, and at the same time the Board of Education will not be put to one cent of expense for the salary of substitutes.

CHEMISTRY BULLETIN.

Bulletins 329 and 375 have been issued by the University of Texas primarily for the benefit of teachers who are interested in the teaching of chemistry. In applying for them teachers should state what positions they hold. No charge is made for the bulletins to teachers in Texas. A charge of $0.50 is made to teachers in other states. Address: Bulletins, University of Texas, Austin, Texas. The first of these two bulletins attempts to increase the efficiency of the chemistry courses in the high schools of Texas by giving specific instructions as to the sort of preparation the teacher should have and the sort of physical equipment that should be furnished for him to work with. In outlining the preparation needed by the teacher it seems to the reviewer that what is suggested should be taken as a minimum requirement rather than as an ideal preparation, and in all probability that was the thought of the author of the bulletin. The specific instructions in regard to constructing and equipping a laboratory seem very practical, and if followed will avoid much difficulty that might otherwise be encountered by a teacher inexperienced in such matters. The provisions as to supplies of chemicals and reagents seem ample, and the annual cost per capita that is suggested would appear generous. The second bulletin deals more specifically with the subject matter of the course in chemistry, and its purpose seems to be to make the work as practical as possible.   F. B. W.

BOOKS RECEIVED.

Elementary Geography, by Harmon B. Niver. Pages vii+360. 20.5x26 cm. Cloth. 1915. Hinds, Noble & Eldredge, New York City.

Evolution, Heredity and Eugenics, by John M. Coulter, University of Chicago. Pages iv+133. 13x18 cm. Cloth. 1915. 50 cents. John G. Coulter, Publisher, Bloomington, Ill.

Reproduction, by Thos. W. Galloway, Beloit College. Pages vi+144. Cloth. 1915. 60 cents. John G. Coulter, Publisher, Bloomington, Ill.

How to Become Personally Efficient in Business. 128 pages. 13x19 cm. Cloth. 1915. A. W. Shaw Company, Chicago.

The Book of Stars, by A. F. Collins. Pages xv+230. 13x19.5 cm. Cloth. 1915. D. Appleton & Co., New York.

Engineering as a Career, by F. H. Newell, University of Illinois, and C. E. Drayer. Pages xii+214. Cloth. 1915. $1.00 net. D. Van Nostrand Company, New York.

Modes of Research in Genetics, by Raymond Pearl, Maine Agricultural Experiment Station. Pages vii+182. 13.5x19.5 cm. Cloth. 1915. $1.25. The Macmillan Company, New York.

The Principles of Agronomy, by Franklin S. Harris and George Stewart, Utah Agricultural College. Pages xvi+451. Cloth. 1915. The Macmillan Company, New York.

Catalog of Physical Apparatus. 146 pages. 15.5x23 cm. Cambridge Botanical Supply Company, Waverley, Mass.

Robert of Chester's Latin Translation of the Algebra of Al-Khowarizmi, by Louis C. Kaspinski, University of Michigan. Pages vii+164. 18.5x27 cm. Paper. 1915. The Macmillan Company, New York.

Selection and Preparation of Food, by Isabel Bevier and Anna R. Van Meter, University of Illinois. 110 pages. 13x20 cm. Cloth. 1915. 75 cents net. Whitcomb & Barrows, Boston.

Food and Nutrition, by Isabel Bevier, University of Illinois. 80 pages. 13x20 cm. Cloth. 1915. $1.00 net. Whitcomb & Barrows, Boston.

Being Well-Born, by Michael F. Guyer, University of Wisconsin. Pages xxiii+374. 13x19 cm. Cloth. 1915. $1.00 net. The Bobbs-Merrill Company, Indianapolis.

Commerce and Industry, by J. Russell Smith, University of Pennsylvania. Pages viii+596. Cloth. 1916. Henry Holt & Co., New York.

General Chemistry for Colleges, by Alexander Smith, Columbia University. Pages x+662. 14x20.5 cm. Cloth. 1916. $2.25. The Century Company, New York.

Selected Readings for Students in Elementary College Zoology, by Harold S. Colton. 42 pages. 15.5x23 cm. Paper. 1915. 25 cents. Department of Zoology, University of Pennsylvania, Philadelphia.

ERRATUM.

In the February advertisement of Eimer and Amend, the catalog numbers under the beakers and the Florence flask were misplaced. The numbers should be placed as in this issue, 737 under the beakers and 3039 under the flask.

BOOK REVIEWS.

First Aid in the Laboratory and Workshop, by Arthur A. Eldridge and H. V. A. Briscoe, England. Pages v+32. 12.5x18.5 cm. Cloth. 1915. 35 cents. Longmans, Green & Co., New York City.

Unquestionably a splendid little book, which should be near at hand in every workshop and laboratory where workmen or pupils are likely to be injured or poisoned in any one of a thousand or more ways. The volume is a remarkable treatise on first aid in an emergency. It contains directions on how to proceed in prescribing for an individual who has met with an accident. It contains a list of materials which should be on hand in every room designated above. The price is so unusually low that the book is within the reach of everyone in charge of a workshop or laboratory. It is surely worthy of being placed in every room where need of its information might arise. C. H. S.

Elementary Geography, by Herman B. Niver. Pages vii+360. 20.5x26 cm. Cloth. 1915. 75 cents. Hinds, Noble & Eldredge, Philadelphia.

This is one of the very recent, modern geographies, and it has been compiled by one who has given much attention to the subject. It is written in such an attractive style that the young grader will at once be drawn to the book. It has over four hundred maps and illustrations, most of which are here produced for the first time. Great care has been taken in the selection of these, in order that they may illustrate most vividly the points in question. One splendid feature of the book is the fact that the maps of the sections of the United States, as well as those of Europe, are drawn to scale with each other, thus enabling the pupil to make correct comparisons. In many texts heretofore published, a map of some of the New England states, for instance, was made as large as the state of Texas. This was very misleading. There is an abundance of material in this volume, in fact more than can be used by the teacher in the time she has to devote to the subject. This is a good fault, however, as the instructor has the opportunity of selecting that which will be best suited to the grade of pupils. There are many valuable statistics given, and also several pages are devoted to the index and the pronunciation of geographical terms. Profile and relief maps, as well as political maps, are found in the appendix. The book is well bound, and will withstand hard usage. It is one that is worthy of a very large circulation. C. H. S.

Elementary Lessons in Electricity and Magnetism, by Sylvanus P. Thompson, University of London. Seventh edition. Pages xv+706. 14x20 cm. Cloth. 1915. The Macmillan Co., New York City.

To those people who are familiar with physics, it is not necessary to give an extended review of this book, as they are all familiar with Thompson. However, in this seventh edition the older works have been entirely revised and in many cases the parts have been completely rewritten. The tremendous strides which have been made during the last decade in the industrial applications of electricity have compelled a complete revision of the latter part of the book. A chapter has been added on "Wireless Electricity," and also one on the "Electron Theory of Electricity." It is a volume of unquestioned authority, and one which all progressive teachers of physics and students of electricity should have in their libraries.

C. H. S.

Laboratory Accommodation in Continuation Schools and High Schools and Collegiate Institutes, by George A. Cornish, University of Toronto. Pages viii+144. 16.5x25 cm. Cloth. 1915. L. K. Cameron, Toronto.

There are many science instructors who are absolutely at a loss to know where to go to secure information which will enable them to reequip their laboratories in a modern, up-to-date manner. Such a text as this, if placed

in their hands, will at once eliminate many of their difficulties, as it is a book designed and written primarily for the purpose of giving science folk a boiled-down synopsis of the very best descriptive matter relating to laboratory equipment that is published. There are eighty-one drawings and figures of laboratory apparatus, laboratory tables, teachers' tables, and plans of arrangements of laboratories. It is a book that all science teachers who are contemplating making changes in their laboratories or who expect to make plans for new laboratories, should have in their possession.

                                                                    C. H. S.

A Treatise on Light, by R. A. Houstoun, University of Glasgow. Pages
        xi+178. 15x23 cm. Cloth. 1915. $2.25 net. Longmans, Green &
        Co., New York City.

This is a new work on the theory of light, and is written by one more than competent to produce such a book, and consequently it is authoritative. The language is clear, concise, and distinct. The volume is intended for those college students who have had at least one year in physics, and who are intending to pursue in detail a study of light. A thorough knowledge of elementary mathematics, together with calculus, is absolutely necessary for a clear and complete understanding of the book. There are 328 drawings and illustrations scattered throughout the text, most of them being especially prepared for the work. There are many examples bearing directly upon the subject matter, and these are in most cases found at the ends of the chapters.

The text is divided into four parts—Part I being "Geometrical Optics;" Part II, "Physical Optics;" Part III, "Spectroscopy and Microscopy;" and Part IV, "A Mechanical Theory of Light." There are, altogether, twenty-four chapters in the volume. The major paragraphs begin with bold-faced type, and these sentences in almost every case state the subject matter treated in the paragraphs. There is also a well-made appendix. It is an admirable production, and should be in every physics library.

                                                                    C. H. S.

*The Orders of Architecture, by A. Benton Greenberg, Stuyvesant High
        School, New York City.* 20 full page, loose-leaf problem sheets.
        20x26.5 cm. Paper. 1915. 50 cents. John Wiley & Sons, New York
        City.

Another monograph from this publishing house has just appeared. It is a splendid little work, and tells in a very precise and detailed drawing way the order of architecture. The drawings are magnificently executed, and the detail is almost perfect. Drawing teachers surely will find something here that will enable them to make their instruction much easier.

                                                                    C. H. S.

*Evolution, Hederity and Eugenics, by John Merle Coulter, University of
        Chicago; and Reproduction, by Thomas Walton Galloway, Beloit Col-
        lege.* Pages 133 and 144, illustrated. 12x18 cm. Cloth. 50 cents and
        60 cents. Published by John G. Coulter, Bloomington.

The above are two volumes recently added to the *School Science Series,* which is being issued by Mr. Coulter as editor and publisher. Mr. Coulter has certainly done good service in enlisting the authors in the preparation of these two books. The books are written in nontechnical style, but at the same time with such great clarity and brevity that the subjects are covered in a very comprehensive manner. It would be hard to find anywhere better statements of these two great topics than is to be found in these two little books. They ought to be in every teacher's library, and will probably also fill the need for concise textbooks of these two subjects. They are also adapted to the use of the general reader, who may be interested in these important topics.   W. W.

Allgemeine Biologie, redaktion C. Chun and W. Johannsen unter mitwirkung von A. Günthart. With 115 illustrations in the text. Pages xi+691. 17x26 cm. Price 23m. Published by B. G. Teubner, Leipzig and Berlin.

This volume is one of a series under the general title of *Die Kultur der Gegenwart,* covering the field of natural science and other sciences. It is written by specialists in the various lines of research included within its scope. Each specialist has written a signed chapter on a topic assigned by the editors, the whole arranged in logical order by the editors. There are nineteen writers altogether. The book does not deal with technical morphology as such, but rather with the general theories and discoveries of biology. It will be particularly valuable, therefore, to biologists on this account, covering, as it does, the latest researches of biologists, which otherwise must be looked for in widely scattered publications.

Some of the more important topics included in its pages, which will give a good conception of the general plan of the book, are: Das Wesen des Lebens; Lebenslauf, Alter und Tod des Individuums; Protoplasma; Mikrobiologie; Regeneration und Transplantation im Tierreich; im Pflanzenreiche; Experimentelle Grundlagen der Deszendenzlehre.   W. W.

Analytic Geometry, by H. B. Phillips, Ph. D., Assistant Professor of Mathematics in the Massachusetts Institute of Technology. Pages vii+197. 13x19 cm. $1.50. 1915. John Wiley & Sons, Inc., New York.

There is much in the plan of this book and in the way in which the plan has been worked out to commend it to the attention of instructors in mathematics. It is a short course in analytic geometry, but when the student has mastered it he has a much better equipment for future work than is usually afforded by a book of the old type, which gives all the petty details of the subject.

The slope form of the equation of the straight line is sufficient for all

purposes. To get the equation of the ellipse by deforming a circle is to establish a very prac'.:al relation between the two curves. The treatment of the general equation of the second degree is brief but adequate. Graphs and empirical equations, intersection of curves, locus problems, parametric representation, and a brief discussion of curves and surfaces in space complete this excellent short course.   H. E. C.

Elementary Algebra, by H. E. Slaught, Professor of Mathematics in the University of Chicago, and N. J. Lennes, Professor of Mathematics in the University of Montana. Pages x+357. 14x19 cm. 1915. Allyn & Bacon, Boston.

This book is not a revision of the authors' *First Principles of Algebra*, but a new book, designed to meet the most exacting requirements of college entrance or other examination boards of various states. Among the distinctive features mentioned are the following : The presentation of the subject is as simple as it can be made. There is an unusually large number of problems and exercises. Vital purpose is given by using algebra to do interesting and useful things. Emphasis is given to the human interest of algebra. There are ten portraits of mathematicians, with accounts of their lives and their contributions to mathematics, especially to algebra. No doubt this book will prove satisfactory in the hands of teachers who are preparing pupils for college entrance examinations; and most of us will share the hope of the authors that its use will still further extend *the concrete study of algebra.*   H. E. C.

Plane Geometry, by John C. Stone, Head of the Department of Mathematics, State Normal School, Montclair, N. J., and James F. Millis, Head of the Department of Mathematics, Francis W. Parker School, Chicago. Pages x+276. 14x19 cm. 85 cents. 1916. Benj. H. Sanborn & Co., Chicago.

When one really breaks away from the traditional treatment of a subject, he is apt to go too fast and too far. The Stone-Millis *Geometry*, published in 1910, did really get at the subject from the viewpoint of present-day requirements and new educational ideals, departing widely from the geometry of the ancient Greeks. But those of us who have used the book feel, no doubt, that the work was done with good judgment; and it it interesting to see that the authors have not found it necessary to change the main features of the older book in this revision.

In broad outline, it remains the same, while greatly improved by minor changes throughout. At the beginning, complete proofs of more theorems are given, which provide the pupils with a larger number of perfect models for their own proofs. The majority of proofs of theorems are left for the pupils to work out, and the character of the suggestions has been greatly improved. The exercises have been thoroughly revised, and many new ones have been added. New cuts have been made for all the figures, and a better arrangement of material on the pages secured.

Because of the large increase of younger pupils entering high schools, a concrete approach to geometry is of the highest importance. The introductory work in this book is well devised to acquaint the pupils with the tools of geometry, and with the definitions, axioms, and other fundamental ideas. Moreover, it connects well with the demonstrative work that follows, and makes the pupil feel the need of using the instruments for accurate constructions in all attempts to solve evercises and prove theorems. This book will surely find favor with teachers who wish to give their pupils not only a drill in clear and logical thinking, but also an insight into the practical uses of geometry and a facility in working applied problems which they may find useful in all fields of endeavor.   H. E. C.

Bacteriological Methods in Food and Drugs Laboratories with an Intro-duction to Micro-analytical Methods, by Albert Schneider, M. D., Ph. D. (Columbia University) Professor of Pharmacognosy and Bacteriol-ogy in the College Pharmacy of the University of California, San Francisco. Pages · viii+288. 14.5x20x2 cm. 87 illustrations and 6 full page plates. Cloth. 1915. $2.50 net. P. Blakiston's Son & Co., Philadelphia.

This new manual is intended primarily for the use of students in the bacteriological examination of foods and drugs. The first eighteen pages are given to an outline of micro-analytical methods. Here the necessary equipment is described, and many special tests for foods and drugs are given.

The earlier parts of the main text are occupied with accounts of the methods employed by bacteriologists in their work, such as the preparation of the various culture media. The technique of making bacteria counts is the subject of another important section of the work. Evidence of sewage contamination of public water supplies is given considerable attention, and the methods given seem to be thoroughly up to date. The remainder of the book is given over to accounts of the methods in use for the examination of specific substances and types of substance, as, for example, meats and meat products, eggs and egg products, pharmaceutical preparations, syrups, fermented foods and beverages, disinfectants, etc. The two final chapters deal with the determination of the purity and quality of sera, bacterins and related products, and with special biological and toxicological tests. In addition to its value as a text, the work should be a valuable reference book in any scientific library and especially in the libraries of food and drug laboratories.   F. B. W.

ROCK COMPOSED OF MINUTE FOSSILS.

Near Reno, Nev., are peculiar beds of diatomaceous earth. This chalk-white material consists largely of fossil microscopic animals called diatoms. These remains have collected here in numbers so immense as to form deposits hundreds of feet thick and in places make up almost the entire mass of the rock. This mass of fossil diatoms, or diatomaceous earth, formerly called infusorial earth, differs from white chalk only in that it is composed of silica instead of lime carbonate. It is so light that it will almost float on water.—*Overland Guidebook, U. S. Geological Survey.*

DIRECTORY OF SCIENCE AND MATHEMATICS SOCIETIES.

Under this heading are published in the March, June, and October issues of this journal the names and officers of such societies as furnish us this information. We ask members to keep us informed as to any change in the officiary of their society. Names are dropped when they become a year old.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

President, Charles Richard Van Hise, University of Wisconsin, Madison, Wis.; *Vice-Presidents:* Section A.—Luther P. Eisenhart, Princeton University, Princeton, N. J.; Section B.—Henry A. Bumstead, Yale University, New Haven, Conn.; Section C.—(No. election); Section D.—Elmer L. Corthell, Brown University, Providence, R. I.; Section E.—Rollin D. Salisbury, University of Chicago, Chicago, Ill.; Section F.—George H. Parker, Harvard University, Cambridge, Mass.; Section G.—Thomas J. Burrill, University of Illinois, Urbana, Ill.; Section H.—Frederick W. Hodge, Smithsonian Institution, Washington, D. C.; Section I.—Louis I. Dublin, Metropolitan Life Insurance Co., New York, N. Y.; Section K.—(No election); Section L.—Leonard P. Ayres, Russell Sage Foundation, New York, N. Y.; Section M.—Whitman H. Jordan, N. Y. Agricultural Experiment Station, Geneva, N. Y.; *General Secretary,* William E. Henderson, Ohio State University, Columbus Ohio; *Secretary of the Council,* C. Stuart Gager, Brooklyn Botanic Garden, Brooklyn, N. Y.; *Permanent Secretary,* L. O. Howard, Smithsonian Institution, Washington, D. C.; *Associate Secretary for the South,* Robert M. Ogden, University of Kansas, Lawrence, Kan.; *Secretary of Pacific Division,* Albert L. Barrows, University of California, Berkeley, Cal.; *Secretaries of the Sections:* A.—Mathematics and Astronomy, Forest R. Moulton, University of Chicago, Chicago, Ill.; B.—Physics, William J. Humphreys, U. S. Weather Bureau, Washington, D. C.; C.—Chemistry, John Johnston, Geophysical Laboratory, Carnegie Institution of Washington, Washington, D. C.; D.—Engineering, Arthur H. Blanchard, Columbia University, New York, N. Y.; E.—Geology and Geography, George F. Kay, State University of Iowa, Iowa City, Iowa; F.—Zoology, Herbert V. Neal, Tufts College, Mass.; G.—Botany, Albert F. Blakeslee, Cold Spring Harbor, N. Y.; H.—Anthropology and Psychology, George G. MacCurdy, Yale University, New Haven, Conn.; I.—Social and Economic Science, Seymour C. Loomis, 69 Church Street, New Haven, Conn.; K.—Physiology and Experimental Medicine, Charles E. A. Winslow, Yale Medical School, New Haven, Conn.; L.—Education, Stuart A. Courtis, Department of Educational Research, Detroit, Mich.; M.—Agriculture, Edwin W. Allen, Office of Experiment Stations, U. S. Department of Agriculture, Washington, D. C.; *Treasurer,* R. S. Woodward, Carnegie Institution of Washington, Washington, D. C.; *Assistant Secretary,* F. S. Hazard, Office of the A. A. A. S., Smithsonian Institution, Washington, D. C.—116.

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

President, C. Gordon Hewitt, Ottawa, Canada; *Secretary,* A. F. Burgess, Melrose Highlands, Mass.—116.

AMERICAN GEOGRAPHICAL SOCIETY.

President, Mark Jefferson, Ypsilanti, Mich.; *First Vice-President*, J. Russel Smith, Swarthmore, Pa.; *Second Vice-President*, J. Paule Goode, University of Chicago, Chicago, Ill.; *Secretary*, Isaiah Bowman, Broadway at 156 Street, New York City; *Treasurer*, F. E. Marrhes, U. S. Geological Survey, Washington, D. C.—116.

AMERICAN MATHEMATICAL SOCIETY.

Vice-Presidents, Prof. E. R. Hedrick, University of Missouri, Columbia, Mo.; Prof. Virgil Snyder, 214 University Avenue, Ithaca, N. Y.; *Secretary*, Prof. F. N. Cole, Columbia University, New York City; *Treasurer*, Prof. J. H. Tanner, Cayuga Heights, Ithaca, N. Y.; *Librarian*, Prof. D. E. Smith, Teachers College, Columbia University, New York City.—116.

AMERICAN MICROSCOPICAL SOCIETY.

President, Prof. M. F. Guyer, University of Wisconsin, Madison; *First Vice-President*, Prof. T. L. Hankinson, Eastern Illinois Normal School, Charleston, Ill.; *Secretary*, Prof. T. W. Galloway, Beloit College, Beloit, Wis.; *Treasurer*, Dr. H. J. VanCleave, University of Illinois, Urbana, Ill.; *Custodian*, Mr. Magnus Pflaum, Meadville, Pa.—116.

AMERICAN PALEONTOLOGICAL SOCIETY.

President, R. Ruedemann, Albany, N. Y.; *Vice-President*, R. W. Vaughan, Washington, D. C.; *Secretary*, R. S. Bassler, Washington, D. C.; *Treasurer*, Richard S. Lull, New Haven, Conn.; *Editor*, Charles S. Eastman, New York City.—116.

AMERICAN PHYSICAL SOCIETY.

President, R. A. Millikan, University of Chicago, Chicago, Ill.; *Vice-Presidents*, H. A. Bumstead, Yale University, New Haven, Conn.; *Secretary*, A. D. Cole, Ohio State University, Columbus, Ohio; *Treasurer*, J. S. Ames, Johns Hopkins University, Baltimore, Md.—116.

AMERICAN SOCIETY OF NATURALISTS.

President, Raymond Pearl, Maine Agricultural Experiment Station, Orono, Me.; *Vice-President*, Albert F. Blakeslee, Carnegie Station of Experimental Evolution, Cold Spring Harbor, N. Y.; *Secretary*, Bradley M. Davis, University of Pennsylvania, Philadelphia; *Treasurer*, J. Arthur Harris, Carnegie Station of Experimental Evolution, Cold Spring Harbor, N. Y.—116.

ASSOCIATION OF OHIO TEACHERS OF MATHEMATICS AND SCIENCE.

President, E. W. E. Schear, Otterbein University, Westerville; *Vice-President*, W. E. Anderson, Wittenberg College, Springfield; *Secretary-Treasurer*, H. H. Reighley, East High School, Columbus; *Assistant Secretary*, Annie Smead, Scott High School, Toledo.—116.

ASSOCIATION OF TEACHERS OF MATHEMATICS IN NEW ENGLAND.

President, Prof. Julian L. Coolidge, Harvard University; *Vice-President*, Prof. Frank C. Moore, Durham, N. H.; *Treasurer*, Frederick W. Gentleman, Mechanic Arts H. S., Boston.—116.

ASSOCIATION OF TEACHERS OF MATHEMATICS IN THE MIDDLE STATES AND MARYLAND.

President, Jonathan R. Rorer, William Penn High School, Philadelphia; *Vice-President*, Elizabeth B. Cowley, Vassar College, Poughkeepsie, N. Y.; *Treasurer*, Edward D. Fitch, 4035 Locust Street, Philadelphia; *Secretary*, F. Eugene Seymour, State Normal School, Trenton, N. J.—116.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

President, Herbert R. Smith, Lake View High School, Chicago; *Secretary*, A. W. Cavanaugh, Lewis Institute, Chicago; *Treasurer*, John H. McClellan, Harrison Tech. High School, Chicago; *Vice-President*, Edith Long, Lincoln High School, Lincoln, Neb.; *Cor. Secretary*, Charles W. Newhall, Shattuck School, Faribault, Minn.; *Assistant Treasurer*, H. Clyde Krenerick, N. Division High School, Milwaukee, Wis.; Agriculture—*Chairman*, Henry N. Goddard, State H. S. Inspector, Madison, Wis.; *Secretary*, Harry Bowen, Englewood High School, Chicago, Ill.; Biology—*Chairman*, Fred T. Ullrich, Normal School, Plattesville, Wis.; *Secretary*, Nettie M. Cook, High School, Springfield, Ill.; Chemistry—

Chairman, S. G. Engle, Gary, Ind.; *Secretary*, Frances Church, East High School, Des Moines, Iowa; Earth Science—*Chairman*, Marion Sykes, Bowen High School, Chicago, Ill.; *Secretary*, Meta Mannhardt, Evanston Tp. High School, Evanston, Ill.; Home Economics—*Chairman*, Edna N. White, Ohio State University, Columbus, Ohio; *Secretary*, Grace Gordon Hood, Lewis Institute, Chicago, Ill.; Mathematics—*Chairman*, J. W. A. Young, University of Chicago; *Secretary*, Marie Gugle, Supervisor of High Schools, Columbus, Ohio; Physics—*Chairman*, Earl R. Glenn, Harrison Tech. High School, Chicago; *Secretary*, James E. Weyant, Shortridge High School, Indianapolis, Ind.—116.

CHEMISTRY TEACHERS' CLUB OF NEW YORK CITY.
President, W. L. Estabrooke, College of the City of New York; *Vice-President*, B. W. McFarland, New Haven, Conn., High School; *Secretary*, A. E. Roberts, Yonkers, N. Y., High School; *Treasurer*, J. E. Sinclair, Central High School, Newark, N. J.—116.

COLORADO MATHEMATICS ASSOCIATION.
President, Ira M. DeLong, University of Colorado, Boulder; *Secretary-Treasurer*, Grace Ellen Shoe-Smith, North Side High School, Denver, Colo.—116.

KANSAS ASSOCIATION OF MATHEMATICS.
President, Mrs. Mary W. Newson, Washburn College, Topeka, Kan.; *Vice-President*, Emma Hyde, High School, Kansas City; *Secretary-Treasurer*, Eleanor Harris, High School, Hutchinson.—116.

ILLINOIS STATE ACADEMY OF SCIENCE.
President, U. S. Grant, Northwestern University, Evanston; *Vice-President*, E. W. Washburn, University of Illinois, Urbana; *Secretary*, A. R. Crook, State Museum, Springfield; *Treasurer*, H. S. Pepoon, Lake View High School, Chicago; *Publication Committee*, The President, the Secretary and C. H. Smith, Editor SCHOOL SCIENCE AND MATHEMATICS, 5517 Cornell Ave., Chicago.

INDIANA ACADEMY OF SCIENCE.
President, Andrew J. Bigney, Moores Hill College, Moores Hill; *Vice-President*, Amos W. Butler, State House, Indianapolis; *Secretary*, Howard E. Enders, 117 Fowler Ave., W. Lafayette; *Ass't Secretary*, E. B. Williamson, Bluffton; *Treasurer*, William M. Blanchard, Greencastle; *Press Secretary*, Frank B. Wade, Shortridge High School, Indianapolis; *Editor*, Harry E. Barnard, State House, Indianapolis.—116.

IOWA ASSOCIATION OF MATHEMATICS TEACHERS.
President, Maud St. John, East Des Moines High School; *Vice-President*, F. K. Williamson, Ottumwa High School; *Secretary-Treasurer*, Ira S. Candit, Iowa Mathematics Teachers College, Cedar Falls.—116.

IOWA ASSOCIATION OF SCIENCE TEACHERS.
President, F. E. Goodell, North High School, Des Moines; *Vice-President*, L. B. Spinney, Iowa State College, Ames; *Secretary-Treasurer*, Frances Church, East High School, Des Moines; Biology, E. L. Palmer, Iowa State Teachers' College, Cedar Falls; Chemistry, C. N. Kinney, Drake University, Des Moines; Physics, S. F. Hersey, State Teachers' College, Cedar Falls.—116.

MATHEMATICAL ASSOCIATION OF AMERICA.
President, E. R. Hedrick, University of Missouri; *First Vice-President*, E. V. Huntington, Harvard; *Second Vice-President*, G. A. Miller, University of Illinois; *Secretary-Treasurer*, W. D. Cairns, Oberlin College. —116.

MATHEMATICAL AND PHYSICAL SECTION OF THE ONTARIO EDUCATIONAL ASSOCIATION.
Hon. President, W. J. Robertson, St. Catharines; *President*, R. Wightman, Harbord St., College Institute, Toronto; *Vice-President*, W. J. Longheed, Jarvis St., College Institute, Toronto; *Secretary-Treasurer*, Charles Auld, High School, Tilsonburg.—116.
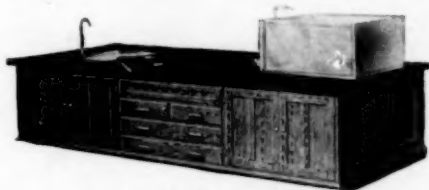
MISSOURI SOCIETY OF TEACHERS OF MATHEMATICS AND SCIENCE.
President, E. B. Street, Independence; *Secretary*, L. D. Ames, Columbia; *Treasurer*, A. J. Schwartz, Cleveland High School, St. Louis; Math-

ematics Division—*Vice-President*, F. W. Urban, Warrensburg; *Secretary*, R. A. Wells, Parkville; Science Division—*Vice-President*, J. E. Wildish, N. E. High School, Kansas City; *Secretary*, Felix Rothschild, Kirksville.—116.

NATURAL SCIENCE SECTION OF THE ONTARIO EDUCATIONAL ASSOCIATION.

Hon. President, Prof. E. F. Burton; *President*, F. P. Gavin, College Institute, Windsor; *Vice-President*, T. J. lvey, Harbord St. College Institute, Toronto; *Secretary-Treasurer*, Arthur Smith, Pardale Coliege Institute, Toronto.—116.

NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS.

President, Ralph W. Channell, High School, South Boston; *Vice-President*, N. Henry Black, Roxbury Latin School, Roxbury, Mass.; *Secretary*, John B. Merrill, East Boston High School; *Treasurer*, Alfred M. Butler, High School of Practical Arts, Boston.—116.

NEW YORK STATE SCIENCE TEACHERS' ASSOCIATION.

President, Ernest F. Conway, Central High School, Syracuse; *Vice-President*, R. C. Gibbs, Ithaca High School, Ithaca, N. Y.; *Secretary-Treasurer*, Harry A. Carpenter, West High School, Rochester; *Committee on Publications*—E. R. Smith, Syracuse, N. Y.; C. B. Herschey, Buffalo, N. Y.; Physics and Chemistry Sections—*Chairman*, W. A. Titsworth, Alfred University, N. Y.; Biology Section—*Chairman*, Carolin A. Riker, Canandaigna Academy, N. Y.—116.

OREGON STATE SCIENCE AND MATHEMATICAL TEACHERS ASSOCIATION.

Chairman, E. E. De Cou, University of Oregon, Eugene; *Secretary-Treasurer*, L. P. Gilmore, State Normal School, Monmouth.—116.

PHYSICS CLUB OF NEW YORK.

President, William F. Evans, Girls High School, Brooklyn; *Vice-President*, Augustus Klock, Ethical Culture High School, New York; *Secretary*, Roland H. Williams, Horace Mann School for Boys, New York; *Treasurer*, Joseph G. Baier, Stuyvesant High School, New York.—116.

SOCIETY FOR PRACTICAL ASTRONOMY.

President, Treasurer *pro tempore*, Frederick C. Leonard, 1338 Madison Park, Chicago, Ill.; *Secretary*, John E. Mellish, R. F. D., Cottage Grove, Wis.; *Council*, the President (Chairman), the Secretary, and Horace C. Levinson, Chicago, Ill.; *Directors of the Observing Sections*, Planetary and Lunar—Latimer J. Wilson, Nashville, Tenn.; Solar—Richard H. Swift, Chicago, Ill.; Spectroscopic—S. F. Maxwell, Dearborn Observatory, Northwestern University, Evanston, Ill.; Photographic—Horace C. Levinson, Chicago, Ill.; Meteor—Charles P. Oliver, Ph. D., Leander McCormick Observatory, the University of Virginia; Comet—William H. Steavenson, London, England; Auroræ, Zodiacal Light and Gegenschein—Alan P. C. Craig, Corona, Cal.; Nova Search—Nels Bruseth, Arlington, Wash.; Section for Construction of Astronomical Instruments—M. Thomas Fullan, B. S., M. E., Alabama Polytechnic Institute, Auburn, Ala.; (unofficial) Section for the Practical Teaching of Astronomy—Mary E. Byrd, Ph. D., Lawrence, Kans.; *Editors*, Frederick C. Leonard and Horace C. Levinson, Chicago, Ill.; *Librarian*—S. F. Maxwell, Evanston, Ill.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

President, H. S. Jacoby, Cornell University, Ithaca, N. Y.; *Vice-Presidents*, G. R. Chatburn, University of Nebraska, Lincoln, Nebr.; F. H. Constant, Princeton University, Princeton, N. J.; *Secretary*, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.; *Treasurer*, W. O. Wiley, 432 Fourth Avenue, New York City; *Assistant Secretary*, L. H. Harris, University of Pittsburgh, Pittsburgh, Pa.—116.

SOCIETY OF AMERICAN BACTERIOLOGISTS.

President, T. J. Burrill, University of Illinois, Urbana, Ill.; *Vice-President*, L. F. Rettger, Yale University, New Haven, Conn.; *Secretary-Treasurer*, A. P. Hitchens, Glenolden, Pa.; *Members of Council*, Dr. Jean Broadhurst, Teachers College, Columbia University, New York City; Dr. Paul F. Clark, U. of Wisconsin, Madison; Mr. L. A. Rogers, Department of Agriculture, Washington, D. C.; Dr. F. H. Slack, Health Department, City Hall Annex, Boston, Mass.—116.